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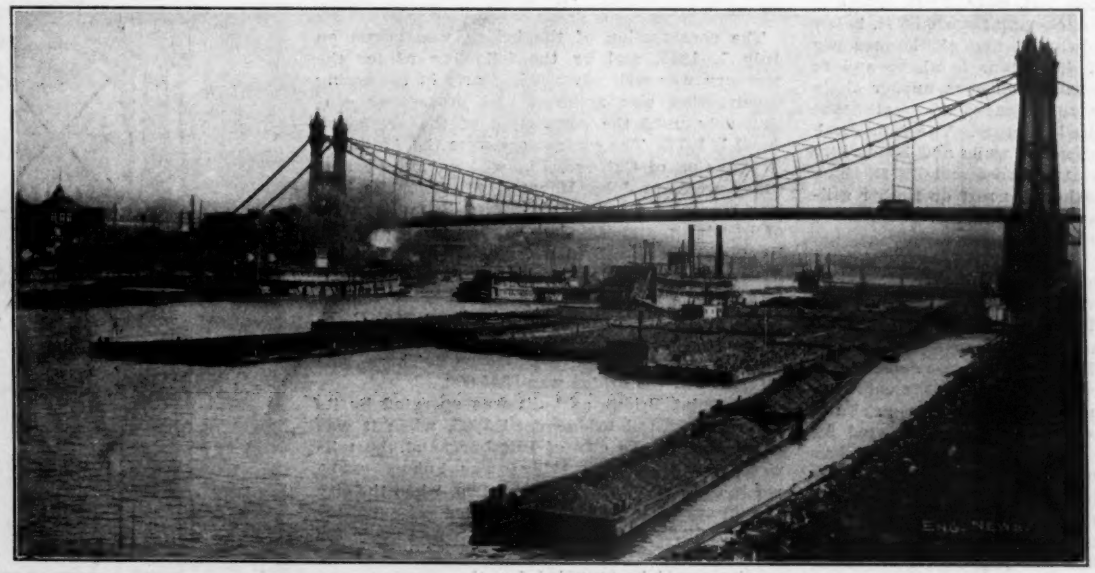
THE POINT BRIDGE AT PITTSBURG, PA., WHICH MUST BE REBUILT.

The rebuilding of the historic Point Bridge at Pittsburg, Pa., has become imperative. On December 24, 1903, four adjacent floor beams bent, buckled and cracked, compelling hasty temporary strengthening and the restriction of traffic to one side of the structure only. The accident was the not unexpected culmination of a series of small detail failures that have resulted from constantly increasing the loads carried by the bridge, and from the long continued neglect to keep the parts known to be overstrained in any decent state of repair for sustaining even the loads they were designed to carry. Conditions have now arrived, therefore, which make extensive reconstruction necessary, and the City Councils of Pittsburg have been asked to appropriate $150,000 for the work.



THE POINT BRIDGE OVER THE MOUTH OF THE MONONGAHELA RIVER AT PITTSBURG, PA., BUILT IN 1877.

At the time of its construction in 1877 the Point Bridge was surpassed in length of span by only two bridges in America—the Niagara railway suspension bridge, 820 ft. long, and the Cincinnati & Covington suspension bridge, 1,057 ft. long, both built by John A. Roebling. It is, moreover, a stiffened chain cable suspension bridge of unique type, and the only chain cable bridge in America. The novelty of this design is not so great now as it was 30 years ago when the bridge was planned. In Roebling's two bridges the stiffening was accomplished by building the floor platform into a pair of rigid girders or trusses, which were hung freely from the cables and were sufficiently strong to distribute the live loads uniformly over the cables. In 1862 the English engineer, Barlow, had introduced in the Lambeth Bridge over the Thames a bracing of crossed diagonals between the cables and the platform. In 1869 a bridge was built over the Main at Frankfort by the German engineer, Schmick, which was similarly braced, and had in addition a hinge in the stiffening girder at the center of the span. With only these precedents the engineer of the Point Bridge adopted a chain cable, the catenary curve of which was subtended by two rigid chords reaching from a common hinge at the center to the opposite tower tops. These chords were braced to the chain by posts and crossed diagonals.

The characteristic features of the design are shown clearly by the elevation and plan, Fig. 1, which are reproduced from Engineering News of July 8, 1876. The chains, each being a catenary curve of equilibrium, take all the dead load without bringing any strains on the stiffening members. This condition was ensured by erecting the bridge complete before the stiffening chords were connected to the center hinge and by making the diagonal rods adjustable by means of turnbuckles. Under live load the stiffening chords are sometimes in compression and sometimes in tension, and they are designed to take both characters of strain.

Before proceeding with the description of the structural details of the Point Bridge, a brief account of the development of the project will be of interest. The bridge was projected and built to be a toll bridge by a private corporation, which secured a charter for the work on Dec. 26, 1874. The difficulties encountered by the builders at the beginning of the work can hardly be realized at the present time. Then the navigation interests exercised practically absolute control over the river. To conciliate these interests and secure their consent to spanning the busy waterway by a bridge was the first task before the builders. The ultimatum of the navigation interests was that the span should not be less than the natural width of the river, and that its clear height should be sufficient to pass the largest boats of the river fleet. After several designs had been prepared the projectors finally settled upon a cable suspension bridge of 800-ft. span, flanked on each side of the river by an independent truss span of 145 ft. and an embankment approach. This plan was worked out by the Consulting Engineer, Mr. Charles Davis, M. Am. Soc. C. E. In May, 1875, bids were asked for constructing the bridge according to the engineer's plans, or according to plans prepared by the bidder to meet the controlling requirements. Bids were received from nearly all the prominent bridge works then existing, and most of the bidders submitted plans of their own for the bridge. These plans included cable suspension, braced arch, Ordish-Lefeuvre suspension, cantilever, and both stiffened and unstiffened chain suspension bridges. From these various plans the builders and their consulting engineer selected one submitted by the American Bridge Co., of Chicago, Ill., and worked out by its Chief Engineer, Mr. Edward Hemberle, as being the most suitable. This is the plan already referred to and shown in Fig. 1, and by the view printed on the first page of this issue, which shows the bridge as it now appears.

The total length of the Point Bridge is 1,245 ft. from back to back of anchorages, with one middle span of 800 ft. and two end spans each 145 ft.

long. The roadway rises from both shores to the center of the bridge on grades of 3½%, and the highest point of the roadway is 83 ft. above low water. The saddles to which the chains are attached at the tower tops are 180 ft. above low water. The deflection of the chain between towers is 83 ft. The bridge is 34 ft. wide c. to c. of

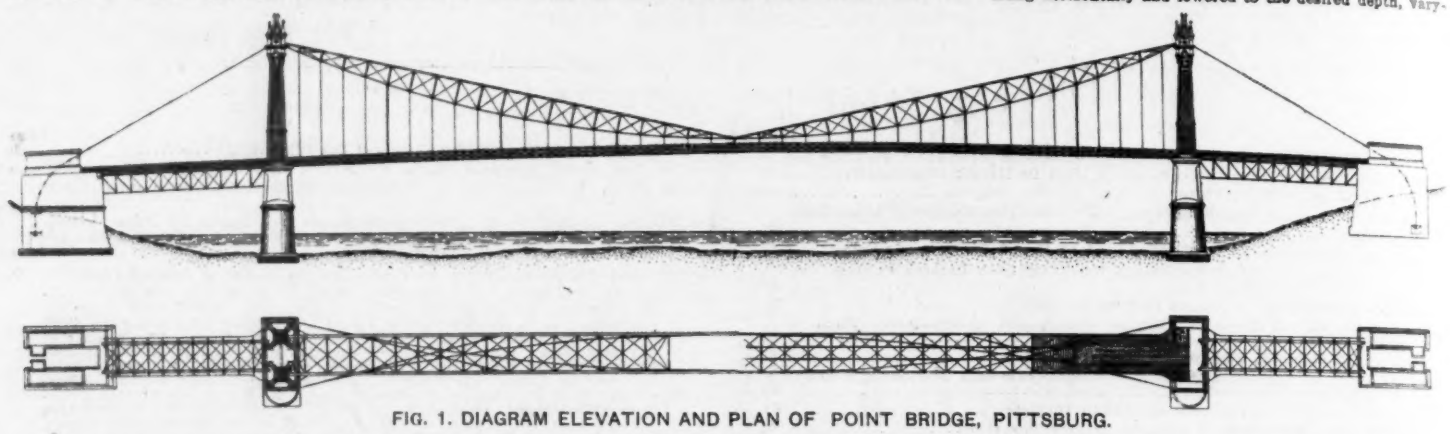


FIG. 1. DIAGRAM ELEVATION AND PLAN OF POINT BRIDGE, PITTSBURG.

rails, and this width is divided into a central roadway 21 ft. wide and two 6½-ft. sidewalks. The anchorages and the piers up to the roadway level are built of masonry of Baden sandstone in cement mortar.

The piers are of solid masonry, resting on a timber grillage sunk to a bed of gravel below low-water level. The construction of the anchorages calls for particular mention, in view of the proposed reconstruction of the bridge. Each anchorage consists of two anchor walls parallel to the center line of the bridge, which are joined at the front end by a cross wall. Each anchor wall is 77 ft. long, 16 ft. thick at the base and 13 ft. thick at the roadway level, and the two walls are 21 ft. apart from outside to outside. Each anchor wall contains 2,400 cu. yds. of masonry. The anchor chains are built into the walls curving downward, as shown by Fig. 1. to the cast anchor plates, which are each 8 ft. wide, 10 ft. long and 2½ ft. thick. These anchor plates are 56 ft. below the grade of the roadway, so that all the masonry having a weight of 4,400 tons is above and in front of them. The strain on each anchor chain when the bridge is fully loaded was estimated by the engineers to be 1,000 tons. The front wall, which joins the two anchor walls and bonds into them, is 18 ft. thick at the base and 7½ ft. thick at the top. Both anchorages rest on timber grillages founded on clay intermixed with large stones. In the case of the south anchorage, the downstream anchor wall settled about ¼-in. more than did the upstream anchor wall, causing a crack in the cross wall joining them. This crack did not enlarge and was the only observed evidence of failure in either anchorage.

The towers of the Point Bridge were constructed of wrought iron except the bases of the columns. They are shown in elevation by Fig. 2. Each tower is composed of twin towers connected by portal bracing, and each of the twin towers has four legs 30 ins. square, with the cross-section shown by Fig. 3. Each twin tower carries a saddle link of wrought iron resting on rollers, as shown by Fig. 4. To one end of this link the back stays or anchor chains are attached, and to the other end is connected the suspension chain.

Both the anchor and the suspension chains are composed of eye-bars linked together by 6-in. pins. The bars are all 20 ft. 6 ins. long and are 8 × 2 ins. and 8 × 1 in. in the body. The links of the anchor chains have alternately 12 and 13 bars, and those of the suspension chains have alternately 11 and 14 bars. The eye-bars were made of the best quality of double-refined iron and, in addition to the usual specimen test, were submitted to a proof strain of ten tons per square inch. The stiffening chords are of box-section with riveted splices. They are connected to the chain at every joint by posts normal to their inclination, and by crossed tie-rods provided with turnbuckles. The crescent girders thus formed are 22 ft. deep at the deepest point.

From these crescent girders are suspended two trusses 8 ft. deep, which are joined across the bridge by lattice girder floor beams 3 ft. deep, spaced 20 ft. apart. The suspenders consist of two 1½-in. rods connecting with each truss every 20 ft. and of rigid posts which replace the suspender rods at every 100-ft. point. The main trusses are continuous, with slip joints every 100 ft. The floor beams are connected by two lines of lattice girder stringers. The drawings of Fig. 5 show the construction described. As will be noticed, the roadway and sidewalk flooring are planking.

The sway bracing is clearly shown by Fig. 5. In addition there is the lateral bracing, shown by the plan, Fig. 1, and a set of lateral cables under the floor. These lateral cables are 2½-in. cast-steel wire ropes, estimated to have an ultimate strength of 210 tons each. The suspension rods were estimated to have a breaking strength of 47 tons each. The tower legs have each a sectional area of 504 sq. ins. The following is a list of the materials used in constructing the bridge:

Timber in foundations, ft., B. M.	1,442,000
Masonry in anchorages, cu. yds.	10,868
Masonry, in piers, cu. yds.	7,507
Iron in foundations, tons	12
Wrought iron in superstructure, tons	2,084
Cast-iron in superstructure, tons	52
Steel in superstructure, tons	32
Timber in superstructure, ft., B. M.	810,000

The construction of the bridge was begun on July 1, 1875, and by the following winter the masonry was well advanced. Early in the spring construction was resumed and prosecuted continuously until the completion of the bridge on April 1, 1877. The contractors were the American Bridge Co., of Chicago, Ill., who sublet the masonry work to John Megraw, of Allegheny, Pa. The iron was furnished by Graff, Bennett & Co., of Pittsburg, and the shop work was done partly by the American Bridge Co. and partly by the Pittsburg Locomotive Works. The eye-bars were forged by the American Bridge Co. The resident engineer in charge of the work was Mr. P. F. Brendlinger, M. Am. Soc. C. E., and the superintendent of erection was Mr. George C. Thorn. The total cost of the bridge was $525,000.

The Point Bridge as built was operated by its owners as a toll bridge until 1895, when it was purchased by the city of Pittsburg and the tolls were abolished. The bridge was known to be weak, especially in the floor system, when the city bought it, and plans were made for extensive repairs in 1896, but no appropriation was made for carrying out the work. In anticipation that the repairs would be provided for, the structure was not kept painted, and some parts of the floor system, none too strong in the first place, were corroded away as much as 30% in places. Heavy electric cars were run over the bridge. It continued to grow worse, numerous rivet heads flew off, lattice bars in the webs of some of the floor beams buckled, and, finally, on Dec. 24, 1903, as already stated, four adjacent floor beams failed, and had to be temporarily strengthened. The proposition now before the City Councils is to appropriate $150,000 for a thorough rebuilding of the bridge.

SHOOTING HOLES IN WELL CASING was a method adopted to develop the flow of water from strata which had been cased off in the water-works wells at Fort Worth, Tex. The water supply system is being enlarged and improved under the direction of Mr. Daniel W. Mead, M. Am. Soc. C. E., Consulting Engineer, of Chicago. The well in question was 8 ins. in diameter, and the plan of shooting holes in the casing was suggested by one of the assistants on the work. The "cannon" was a piece of 2¼-in. steel shafting, 6½ ins. long, with a ¾-in. hole bored to a depth of 4 ins. Pointed projectiles of hard steel were used, with a charge of ½ to ¾-ounce of dynamite, exploded by electricity. The gun was, of course, slung horizontally and lowered to the desired depth, varying from 150 to 800 ft. The method proved very successful, and several guns were used, all of which burst after firing 20 to 25 shots. About 700 to 800 holes were made in this way.

WATER PURIFICATION FOR CLEVELAND, O., has been strongly advised by a special committee of the Ohio State Board of Health, composed of Dr. W. T. Miller, of Cleveland; Dr. W. C. Chapman, of Toledo; and Dr. Josiah Hartzell, of Canton. In the course of a lengthy report the committee calls attention to the gradual increase of chlorine in the lake water supply from 2.8 parts per

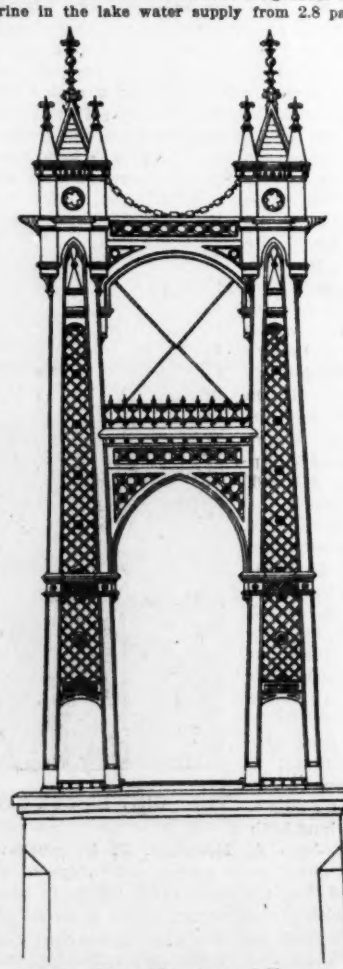


Fig. 2. Front Elevation of Towers of Point Bridge.

1,000,000 in the spring of 1887 to 12.2 in March, 1902, the figure for December, 1903, being 11.7. The typhoid mortality is relatively high and was alarmingly so early in 1903, there having been 1,393 cases and 145 deaths between Jan. 1 and April 17, 1903. The committee does not believe that the completion of the new lake intake tunnel will give safe water, nor even the diversion of the sewage to a point ten miles away by the new outfall sewer.

NOTES ON EARLY CANADIAN TRANSCONTINENTAL RAILWAY PROJECTS.

As a definite project for a second transcontinental railway across the Dominion of Canada is now being promoted by the Canadian government, while two or three other projects are in their preliminary stages (as described in our issues of Oct. 22 and Nov. 5), it will be of interest at this time to briefly review the earlier projects for a Canadian transcontinental line.

The idea of such a road dates back nearly 50 years, for in 1857, in giving evidence before a British government commission in regard to the Hudson Bay Co.'s affairs, Mr. John Ross, President of the Grand Trunk Ry., advocated a railway to the Pacific. In 1860, Mr. (afterwards Sir) Edward Watkin was appointed by a committee of shareholders of the Grand Trunk Ry. Co. to try and straighten out that company's entangled affairs, and in a letter written that year he suggested "a main through railway (of which the first 1,000 miles belong to the Grand Trunk Co.) from the shores of the Atlantic to those of the Pacific." His idea evidently was that the Grand Trunk Ry. should form the eastern section of a transcontinental railway, and after the opening of the Canadian Pacific Ry. he expressed his regret that the two systems had not been managed

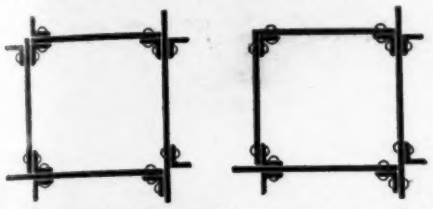


Fig. 3. Typical Sections of Tower Legs of Point Bridge.

on a basis of common interest, which plan would have saved time and money in the completion of a transcontinental line. His preference as to route was to keep as far north of the United States boundary as practicable, using the Yellow-Head Pass through the Rocky Mountains and crossing by a series of islands to Vancouver Island, so as to make the Pacific terminus at Esquimault, which is a British naval station.

In 1862, Mr. Watkin and others were interested in the Intercolonial Ry. project, to connect Halifax with Quebec, and also in a project for a Canadian line to the Pacific, under the auspices of the British and Canadian governments. The Canadian delegates eventually withdrew, however, claiming that the transcontinental line should take precedence of the Intercolonial Ry. In 1863, a "complete intercolonial railway" between the Atlantic and Pacific was suggested, a prospectus then issued, stating that it was expected that it would be executed by the Hudson Bay Co. or with its aid and sanction. In 1868, Mr. Watkin was knighted by Queen Victoria, on account of "his services connected with the international colonial railway." In 1870, the dispute over the territorial rights of the Hudson Bay Co. were concluded, and the government had a free hand as to the development of the country.

It is, perhaps, of passing interest to note that in 1866 a bill was introduced in the United States House of Representatives providing for the admission of the Canadian colonies to the Union, and for government aid in the construction of a railway from Truro (Nova Scotia) to Riviere du Loup (on the St. Lawrence); also from Ottawa to Sault Ste. Marie, Superior (Wis.), Winnipeg (then Fort Garry), and the valley of the North Saskatchewan River, to some point on the Pacific coast north of latitude 49°.

Much of the information given below concerning the history of Canada's first great transcontinental line, the Canadian Pacific Ry., is taken from the address delivered before the American Society of Civil Engineers in 1888 by Mr. Thomas C. Keefer, who was then President of the Society.

In 1871, British Columbia entered the union of Canadian provinces, thus extending the Dominion of Canada to the Pacific Ocean. The principal condition was that the Dominion should, within ten years, build a railway connecting the seaboard of British Columbia with the railway system of Canada, construction to commence at the Pacific coast in 1873. Apart from this condition, however, the line was an urgent necessity to develop the country, and to open up communication between the widely separated provinces. Surveys were immediately commenced and prosecuted for about nine years. The work of construction was not begun until 1875, and then at the Lake Superior end, work at the coast not being commenced until 1879. Some of the delay is accounted for by the fact that the records of the first three years' surveys were destroyed by fire in Ottawa early in 1874.

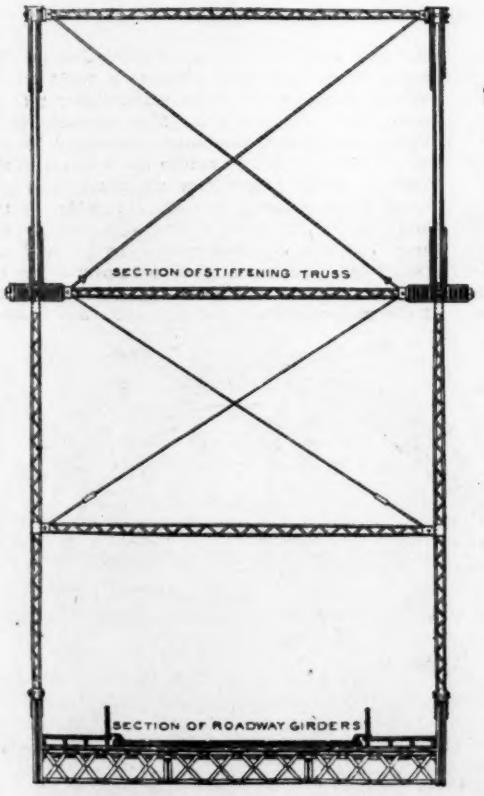


FIG. 5. SECTIONS SHOWING FLOOR AND SUSPENDERS AND SWAY BRACING OF POINT BRIDGE.

The Parliament of Canada decided in 1872 that the road should be constructed and operated by a private corporation subsidized by the government. In that year a contract was arranged with

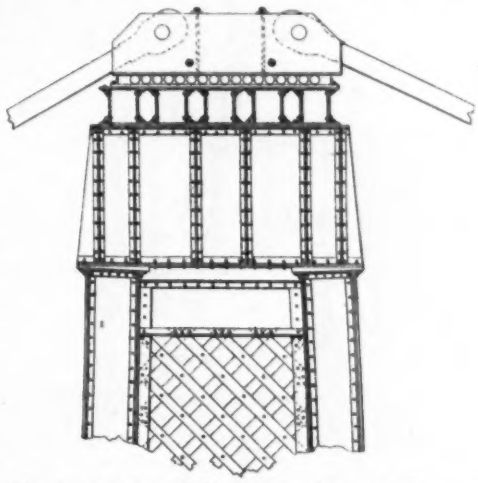


Fig. 4. Saddle and Chain Connections at Tops of Towers.

Sir Hugh Allan for the construction of the line within ten years, and its operation for a similar period, on the basis of a subsidy of $30,000,000 cash and 50,000,000 acres of land. Sir Hugh Allan controlled the Allan line of transatlantic steamers, and desired the railway as an inland connection, but this excited powerful antagonism, and his project was so discredited in the money market that he failed to form his company. The government, headed by Sir John MacDonald, also retired in 1873, after being defeated on a question arising out of this contract. The new government, headed by Sir John Mackenzie, determined in 1874 to proceed with the road as a public work, and in 1875 construction was commenced between Lake Superior and the prairie region, it being intended to have steam ship connections from Port Arthur to the eastern parts of the Dominion. The Mackenzie government was in turn defeated in 1878, and on Sir John Macdonald returning to power he continued the construction as a public work until 1880, when they reverted to their original policy of construction by a private company. The terms of the contract with the present Canadian Pacific Ry. Co. were as follows:

1. $25,000,000 cash and 25,000,000 acres of selected lands, in addition to all right of way through public property.

2. Free importation of all rails, fastenings, fence and bridge material and telegraph wire and instruments for original construction and equipment.

3. The government sections under contract to be completed and handed over to the company as a free gift, but without rolling stock. The first cost of these sections was over $30,000,000, but much of the work was imperfect and had to be subsequently improved to bring it up to the standard. These 700 miles included 430 miles between Lake Superior (Port Arthur) and Winnipeg, 213 miles at the Pacific end (through the Fraser River canyon), and some minor lines in Manitoba.

4. Perpetual exemption from taxation by the Dominion, or any province or municipality, on all property and capital stock.

5. No line south of the railway to be chartered by the Dominion or any province for a period of 20 years, except for lines in a southwest direction.

The company contracted to build about 2,000 miles of railway by 1891, and to work the transcontinental line for ten years after completion. The standard of construction was to be that of the Union Pacific Ry. as it was in 1873. The capital stock was $100,000,000. Liberal as the terms appeared, they proved to be none too liberal, the enterprise being attacked by political and railway

opponents and for some years the company suffered many financial vicissitudes. But in November, 1885, the last spike was driven (in British Columbia) and opposition gradually subsided, when it was seen that the government of Canada was determined to support the railway. In 1887, the company was freed from its indebtedness to the government and placed in uncontrolled possession of its property. In 1888, the government purchased the surrender of the company's monopoly as to charters for lines west of Lake Superior, this being in consequence of a strong demand from the northwest provinces.

The government had located its line from the Red River to the Rocky Mountains in a northwesterly direction, in order to strike the Yellow-Head or Leather pass, which was shown by the surveys to be the most southern practicable pass for a line limited to grades of 1%. The Red River crossing is at about latitude 50°, and the Pacific terminus but little north of the international boundary (49°), while the Yellow-Head pass is in latitude 53°. This deviation from a direct route was more serious for a company line than for a government line, and as the general direction of the road was nearly due west from the Red River crossing at 50°, it was decided by the Canadian Pacific Ry. Co. to follow that parallel as closely as possible. The government consented to the use of any pass south of the Yellow-Head, provided it was at least 100 miles north of the United States boundary, and as grades of 2.2% were permitted the Yelloy-Head pass was abandoned in favor of the Kicking-Horse pass. In this, however, two grades of 4½% were used on a temporary location to save time and money in first construction.

In Canada, the Rocky Mountains maintain a nearly northwest direction, and may be said to terminate as a distinct range between the 51st and 52d parallels; thence descending to the Peace River pass (56°), which is only about 2,000 ft. above sea level. All the rivers on the eastern slope penetrate the range to a greater extent the further north they are found, and the Peace River is the first which cuts entirely through the Rocky Mountain range and heads behind it, draining the table land between the coast range and the Rockies. Between the Peace River and the United States boundary about ten passes were explored, all lowering northward and diminishing from 7,000 ft. to 2,000 ft. The central pass, Yellow-Head pass, with an altitude of 3,733 ft., was selected by the government engineers as above noted. The width of the range decreased from about 60 miles at the 49th parallel to 40 miles or less at the Peace River. The summit of the Kicking Horse pass is crossed at a marsh some 5,300 ft. above sea level, from which the water at flood time flows on both sides of the continental divide. There is therefore no cutting or tunnel in the pass. The heaviest consecutive 100 miles are where the line descends the Thompson and Fraser rivers, cutting through the Coast range. This section, built by the government, cost about $10,000,000, or $80,000 per mile, without rolling stock or stations. The cost for the 2,263 miles of main line was $116,618,000, or an average of $51,530 per mile.

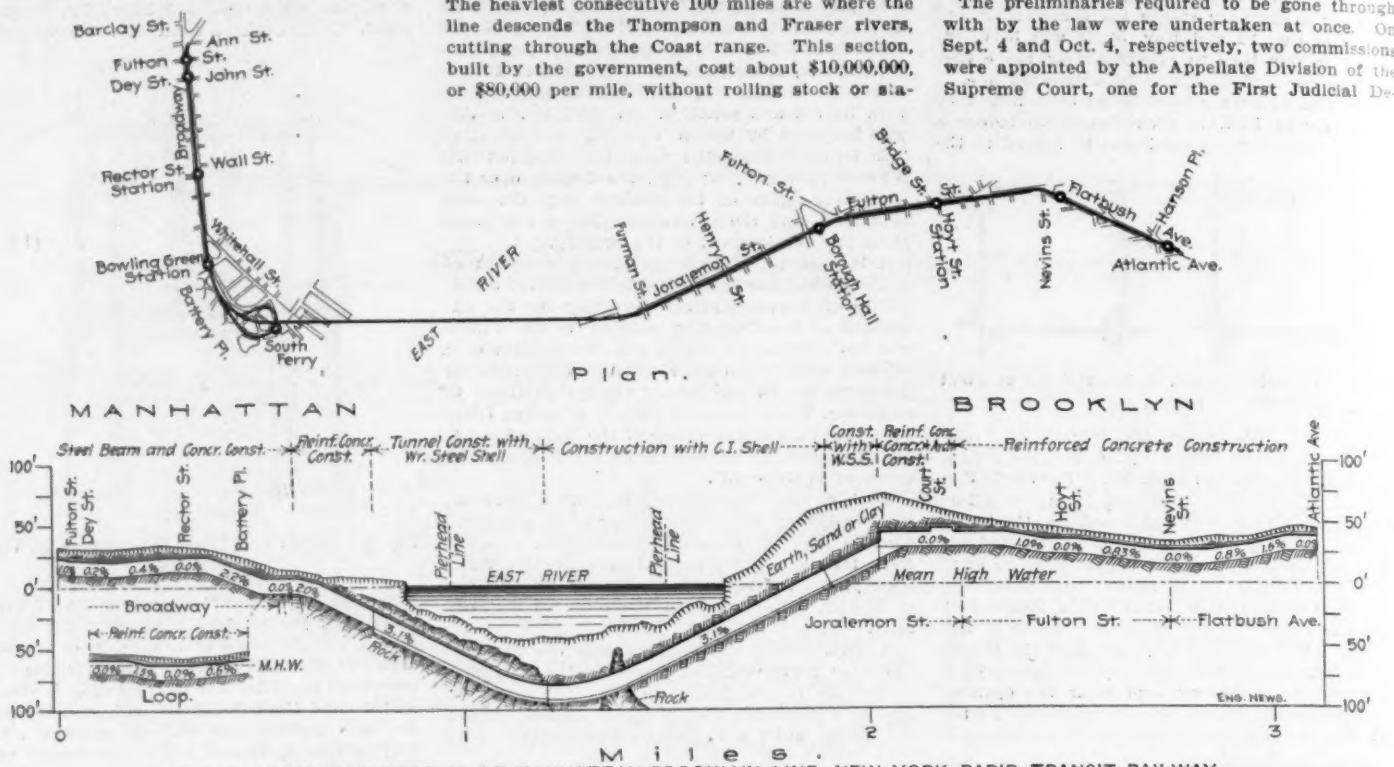


FIG. 1. PLAN AND PROFILE OF MANHATTAN-BROOKLYN LINE, NEW YORK RAPID TRANSIT RAILWAY.

THE NEW YORK RAPID TRANSIT RAILWAY.

XXV.

BROOKLYN-MANHATTAN LINE.

In authorizing the construction of the Rapid Transit Railway for New York City the Appellate Division of the Supreme Court limited the scope of the work by establishing a maximum of expenditure. For this reason the southern terminus of the route was placed at the Post Office or nearly a mile north of the southernmost end of the city. This action left the entire southern portion of the city, with its vast commercial and business population, without convenient access to the new railway, which was a most undesirable condition and one whose evil the Rapid Transit Commission and its engineers recognized and were anxious to correct. Opportunity to do this did not come until 1901, when the debt incurring capacity of the city became sufficient to supply the necessary funds without question. Upon notification of this fact a general plan was adopted for extending the subway from the Post Office south to South Ferry and thence across the East River to Brooklyn. This proposed line was designated officially as Contract No. 2, and became popularly known as the Brooklyn-Manhattan Line.

The preliminaries required to be gone through with by the law were undertaken at once. On Sept. 4 and Oct. 4, respectively, two commissions were appointed by the Appellate Division of the Supreme Court, one for the First Judicial Department and one for the Second Judicial Department, to determine whether a rapid transit railway such as had been planned ought to be constructed and operated. The appointment of these commissions was made necessary by the failure of the Board to secure the consents of the majority of the property owners along the route. These commissions reported favorably to the Court and their reports were approved by the Court on June 30, 1902, and June 17, 1902, respectively. Work was then promptly begun by the Commission's engineers on the detail plans of the projected road and this work was finished and the plans approved by the Commission on June 12, 1902.

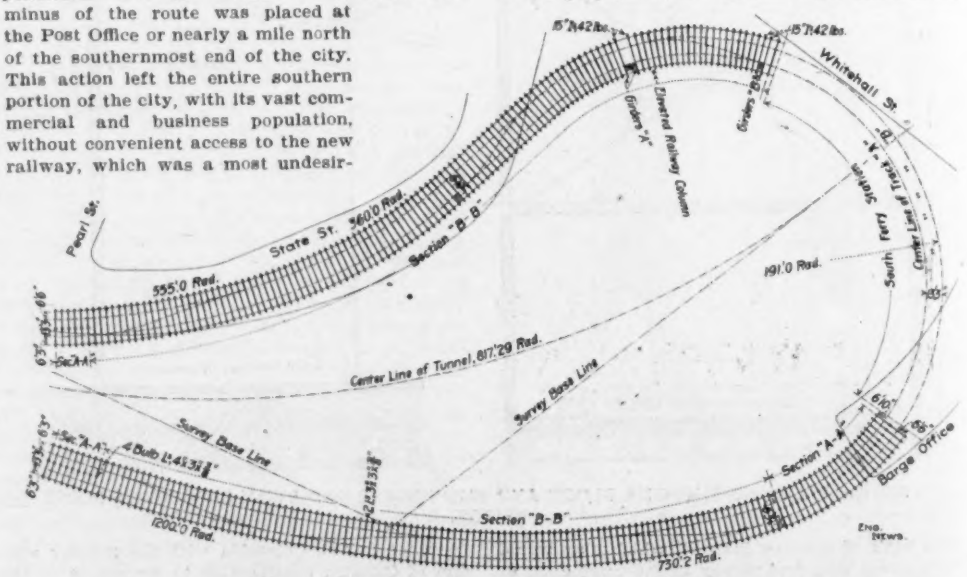


FIG. 2. PLAN OF LOOP LINE AT BATTERY PARK.

ROUTE.—The alinement and profile of the Brooklyn-Manhattan Line are shown by the drawings of Fig. 1. As will be seen, the route begins at Ann St. and Broadway, follows Broadway to Bowling Green and thence curves east under Bat-

tery Park to the East River bulkhead line at the foot of Pier 2, East River. The line then proceeds by deep tunnel under the East River to the foot of Joralemon St., Brooklyn; follows Joralemon St. to Fulton St., and then runs under Fulton St. to Flatbush Ave. and the terminous of the Long Island R. R. Besides the main line just described, there is a branch starting at Bowling Green and forming a loop under Battery Park which reaches to South Ferry. The vertical profile of the line is shown clearly by Fig. 1. As will be seen, the maximum grade is 3.1% where the line passes under the East River.

All portions of the line in Manhattan; the tunnel under the East River; the Joralemon St. line to Clinton St., and the Fulton St. line between Smith St. and Flatbush Ave., are to have two tracks. The remainder of the road will have three tracks. The limits of the double and three-track portions are indicated on the map Fig. 1. The total length of the line is 3.5 miles, composed of 3.1 miles of main line and 0.4 mile of loop line under Battery Park. There are 8 miles of track.

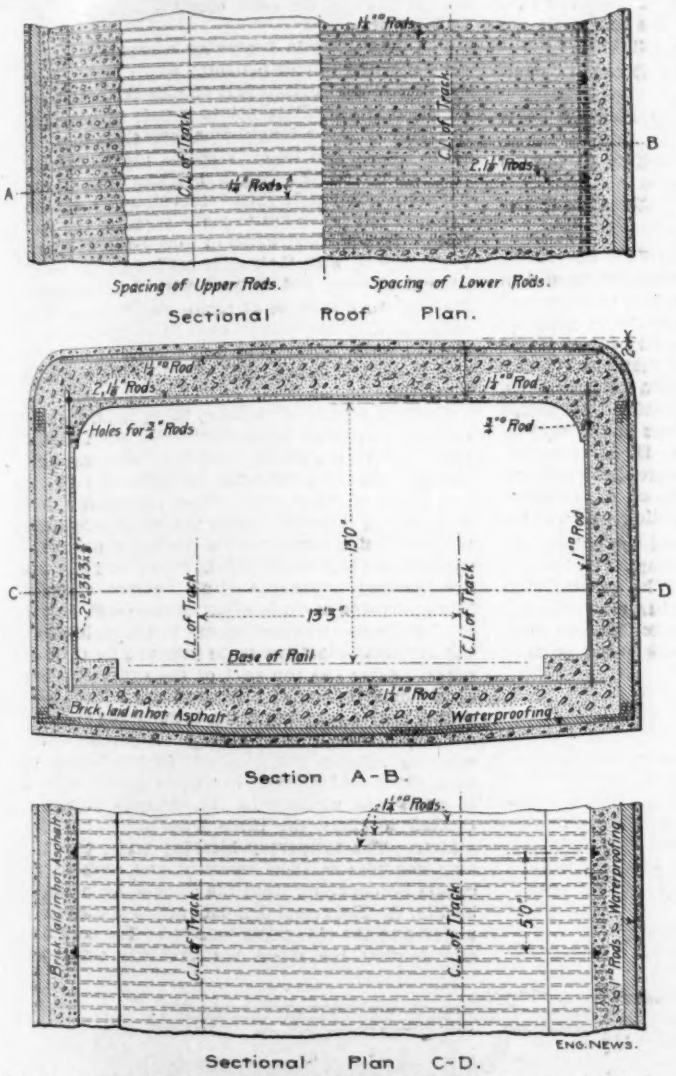


FIG. 3. STANDARD REINFORCED CONCRETE STRUCTURE FOR BATTERY PARK LOOP.

SUBWAY STRUCTURE.—In the Borough of Manhattan and in the Borough of Brooklyn east of Court St., the same general plan of structure was adopted as had been adopted for the original Manhattan line, that is, the roof was brought as close to the surface of the street as subsurface constructions would permit. The exception was made, however, that under Broadway the minimum distance between the subway roof and the street surface was made 6 ft. instead of 30 ins. so as to avoid readjustment of subsurface structures. The reasons for this change were outlined by the engineers of the Commission about as follows: The most annoying detail of work and the one which has caused the greatest delay in the construction of the original Manhattan line was the readjustment of pipes made necessary by bringing the structure so close to the street surface. In streets where rock is encountered, or where traffic is comparatively light, or where pipes are few, the advantages of minimum clearance are paramount. In the Broadway portion of the new line, however, these conditions did not prevail; there was no rock, the traffic was highly congested and the pipes were many and large. The roof of this section was, therefore, depressed, as is noticed above, it being considered that while the distance traveled to and from the station platform would be somewhat increased, the time of construction would be considerably reduced.

The subway structure adopted for the portion of the line just referred to, that is the Manhattan line and the Brooklyn line east of Court St., was of two types. The first type was the structural steel bent and jack arch construction employed for the bulk of the original Manhattan line, and the second type was the reinforced concrete construction adopted for a small portion of the original Manhattan line just constructed. These two types of construction were alternated, as shown by the plan, Fig. 1. The reason for this alternation was that when pipes and street structures were narrow and had to be supported during construction, the steel bent structure afforded great advantages, since the street structures could be blocked up on the bents as soon as they were erected. Furthermore, it was practicable with this construction to erect short and numerous isolated lengths of structure with perfect success in filling the intervals and connecting the earlier and later construction. With the reinforced concrete construction it was desirable that the work should proceed continuously, and it was not practicable, moreover, to block up street structures from the roof until the concrete had hardened. Because of these diverse advantages of the two types of structure, the steel bent type was adopted when piecemeal erection was necessary and when there were many street structures to be supported during construction. On the other hand, when street structures were few and continuous erection was practicable, the reinforced concrete structure was employed because of its saving in materials and time of construction.

BATTERY PARK LOOP.—As will be seen from the profile of Fig. 1, the main line begins just beyond Battery Place to descend on a steep grade for its plunge under the East River. All trains, however, will not go through to Brooklyn, and to provide for the return of these trains a loop is provided under Battery Park. The general location of this loop is shown by the plan of Fig. 1, and its alinement in detail is shown by Fig. 2. The loop line provides for two tracks, and is for the most part on curve. At its end is located the South Ferry Station. Except for the station the construction is reinforced concrete.

There are two types of structure employed, one occupying the sections AA, Fig. 2, having intermediate columns and identical in all respects to the reinforced concrete structure employed on the Lenox Ave. line,* and the other occupying the remainder of the loop and constructed as shown by the drawings of Fig. 3. In this construction all columns are omitted, the structure being an open section of reinforced concrete with an interior width of 25 ft. The general arrangement of the reinforcement is the same as on the Lenox Ave. line, except that the bottom rods in the floor are omitted and the top rods in the roof are carried clear across the structure, while the floor and roof plates are much thicker. On the sharper curves the roof rods are laid with a slight radial alinement across the structure. This design is purely reinforced concrete, and is the first underground railway structure of which this can be asserted.

At two points on the Battery Loop an elevated railway column comes directly over the roof, and special provision was made for carrying these concentrated loads. A steel bent was inserted in the structure on each side of the column and between the two bents under the column I-beams were riveted 12 ins. apart. The construction is shown in detail by Fig. 4. As will be seen, the columns or legs of the bents were I-beams embedded in the concrete side walls and with their tops connected by a plate girder. The other dimensions and details are fully explained by the drawings. In calculating the roof girders the elevated column load of 100,000 lbs. was considered as 200,000 lbs., and the girders were designed for unit strains of 20,000 lbs. per sq. in. in tension and compression and of 10,000 lbs. per sq. in. in shear.

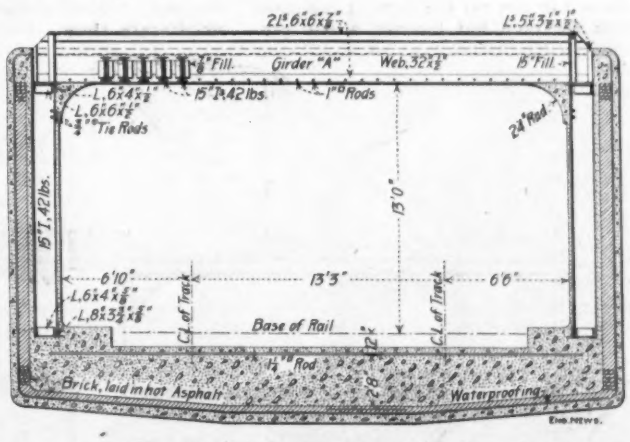


FIG. 4. SPECIAL CONSTRUCTION FOR CARRYING ELEVATED RAILWAY COLUMNS.

EAST RIVER TUNNEL.—The most radical departure on the Brooklyn extension from the forms of subway and tunnel constructions existing on the original Manhattan-Bronx lines was the tunnel under the East River. This work included the section of line between Bowling Green in Manhattan and Court St. in Brooklyn. The width of the East River at the line of crossing is 4,150 ft, between bulkhead lines, with a depth at high water of 47 ft. The mean variation between high and low tides is 4 ft. 7 ins. Several methods were considered for building this section, but finally it was decided to construct a twin tube tunnel and to do the work by means of shields and compressed air. Therefore between a point near the south end of Bowling Green station in Manhattan and Clinton St. in Brooklyn, the structure consists of two iron or steel lined tubes which were put in place by shields working

*Engineering News, Oct. 1, 1903.

toward, each other from shafts on the two shores. The total length of this tube tunnel is 6,550 ft. A transverre section of one of the tubes is shown by Fig. 5 and Fig. 6 is a sketch elevation of a portion of the metal lining.

CONTRACT AND SPECIFICATIONS.—In drawing the specifications for the Manhattan-Brooklyn line, certain changes were made in the original specifications for the Manhattan-Bronx

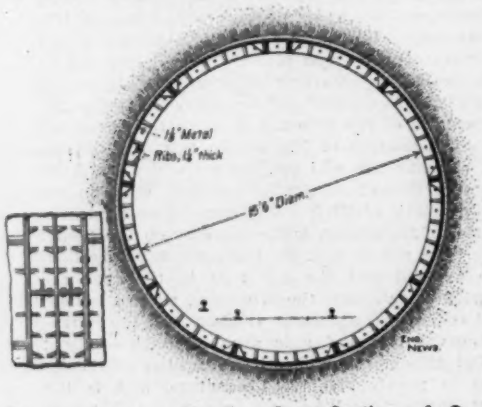


Fig. 6. Elevation of Portion of Lining for Tunnel Tubes.

Fig. 5. Cross-Section of One Tube of East River Tunnel.

line in order to satisfy the differences in the structure, but their general character was the same except that certain provisions tending to shorten the time required for keeping the streets open were introduced. It was stipulated, for example, that, on the sections of the line under Broadway in Manhattan and on Fulton St. in Brooklyn, work should not be begun at any point until a statement had been filed showing that the material required had been acquired and was on hand. It was also required that work should be prosecuted with at least two eight-hour shifts per day.

In drawing the contract the Rapid Transit Commission followed in general the form of the Manhattan-Bronx contract, but inserted a few provisions which made the contract on the whole more favorable to the city then was the original example. As in the original work the contractor was bound both to build the line and to equip and operate it after construction.

CONTRACTORS.—Bids for the construction of the road were opened on July 21, 1902, and the following propositions were received: The Rapid Transit Subway Construction Co. offered to do this work for the sum of $3,000,000 for construction, and $1,000,000 for terminals and real estate. This bid was accompanied by a letter stating that if the bid should be accepted the company would undertake to build a line under Broadway from 42d St. to 14th St. for the nominal consideration of $100,000, provided such contract was awarded it before July 1, 1903. In a later bid the same company offered to do the work without the Broadway line for the sums of $2,000,000 for construction and $1,000,000 for terminals and real estate. In behalf of the Brooklyn Rapid Transit R. R. Co. a bid was submitted offering to do the work for the sums of $7,000,000 for construction and $1,000,000 for terminals and real estate. Both bids were below the estimated cost of the tunnel, which was from $8,000,000 to $10,000,000, and the lowest bid, that of the Rapid Transit Subway Construction Co., was from $5,000,000 to $7,000,000 below. This low bid was accepted and the contract was executed on Sept. 11, 1902. Construction was formally commenced on Nov. 8, 1902, but it was not until Dec. 1 that the construction company announced the names of the subcontractors. These were as follows:

Section I, Ann St. to Bowling Green, Degnon-McLean Constructing Co.

Section II, Bowling Green to Battery Loop, Andrew Onderdonk.

Section III, Bridge St., Manhattan, to Clinton St., Brooklyn, Andrew Onderdonk.

Section IV, Clinton St. to Atlantic Ave., Crawford & McNamee.

CONSTRUCTION OF BROADWAY SECTION.—The portion of the Brooklyn extension, from Ann St. to Battery Park, will be the first to be opened to traffic, and work is now actively in progress at several points. Owing to the very heavy traffic on Broadway, and to the fact that the subway structure reaches practically from curb to curb, it was necessary to devise some mode of procedure which would reduce street openings to a minimum. The contractor's engineer, Mr. H. G. Sanford, Assoc. M. Am. Soc. C. E., therefore, designed and put into execution the method of construction which is described in the succeeding paragraphs.

The general scheme is to build the subway in several independent sections or lengths which will ultimately be joined together. The general plan of the work is to substitute timber platforms for the present street surface and to conduct all work underneath them. To relieve the street surface still further from obstruction, shafts to the workings will be constructed only at intervals, and all the shaft head machinery, material bins, etc., will be installed on overhead bridges crossing the street about 16 ft. above the surface and having a width of about 50 ft.

The construction of the overhead bridges will be described first. This is shown in a general way by the drawings of Fig. 7. A seven-post trestle bent composed of 12 × 12-in. sill, posts and cap, with three sets of X-bracing of 3 × 10-in. planks, is set up on each curb line. On these bents are carried seven 24-in., 80-lb. I-beams, with a bottom lateral bracing of 3 × 3-in. angles and a 3 × 3-in. angle knee brace to the trestle post at each end. On the west side of the street the platform is extended over the sidewalk. To carry the outer end of this extension a third trestle bent is set on the building line and the space between this and the adjacent main bent is spanned by timber beams. The whole platform is floored with 3-in. planks and provided with a sturdy fence boarded tight on all four sides. Mounted on the platform are two stiff-leg derricks set opposite each other at about the middle of the platform. The platform also carries a spoil bin with chutes. The derricks on the platform are operated by compressed air in the daytime, but at night a vertical boiler on one platform and an electric motor on the other supply the necessary power. One platform was located opposite St. Paul's Church at Fulton St., and the other opposite Trinity Church at Wall St.

The first work in beginning excavation was to construct the timber platform which replaced the original street surface just outside the curbs, and at these intermediate points a strip of pavement is removed and a longitudinal trench is dug. In each trench two 24-in. I-beams are placed and blocked up on the trench bottom. The paving between trenches is then removed and a shallow depth of soil taken out to make room for the platform. This is constructed of 8-in. I-beams spaced 7½ ft. apart, with their ends resting on the longitudinal girders, and covered with 6-in. planking. All this work is done at night, and in such short sections that the whole can be completed in a single night's work. The first section of platform was in each instance constructed at the overhead platform.

The first section of platform being built, the succeeding step was to excavate the earth underneath it. First a shaft about 8 ft. wide was sunk through the west sidewalk, as shown by Fig. 7, to a depth of about 10 ft. From this shaft a drift was carried laterally across the street, the street platform being supported by posting down as the excavation progressed. Similar posts and blocking are inserted under the street railway conduits. The excavated earth is taken to the shaft, hoisted out by the derricks and stored in the spoil bin on the overhead platform to be removed by carts at night. After the top part of the excavation has been completed sufficiently to give headroom 5-ft. square shafts reaching down to subgrade are sunk underneath the lines of girders. A portion of the concrete subway floor is built in the bottom of each shaft, and after it has set a post is erected to carry the girder. In this manner posts are erected to carry the three lines of intermediate girders. The temporary blocking under the railway conduits is then removed and replaced by saddle beams slung from the girders, as indicated by Fig. 7. The remaining excavation is then completed and the side posts inserted. The condition now is that the street platform and the street

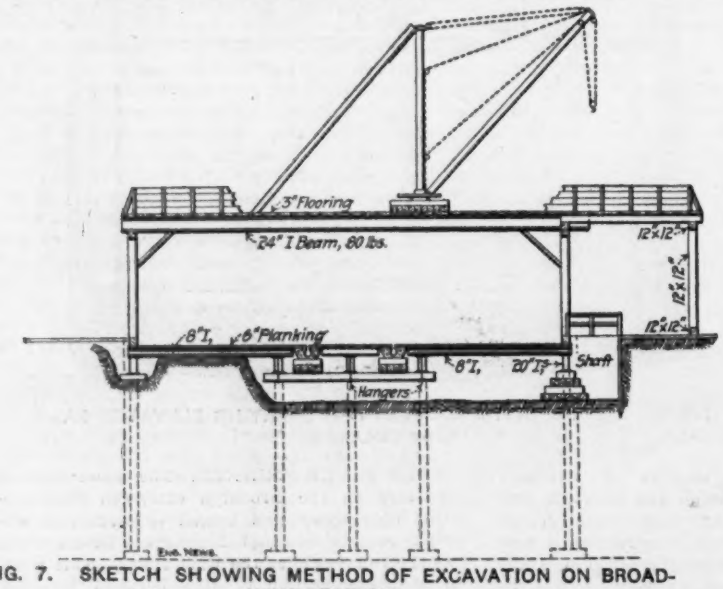


FIG. 7. SKETCH SHOWING METHOD OF EXCAVATION ON BROADWAY SECTION.

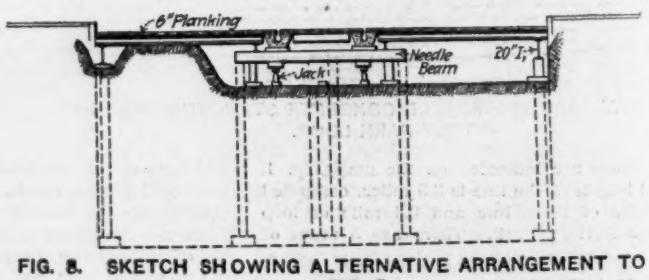


FIG. 8. SKETCH SHOWING ALTERNATIVE ARRANGEMENT TO FIG. 7.

railway conduits are carried over an open excavation by means of a timber trestle. The completion of the subway structure in this open excavation; the back-filling, and the work of repaving finish the work.

When the subsurface excavation is obstructed by pipes and conduits an alternative mode of procedure is followed. Surface platforms are built on each side of the street between the curb and the nearest street railway conduit. A lateral drift is then carried under the street railway conduits and in this drift is inserted a needle beam, which

is blocked up against the undersides of the conduits. These beams carry on their outer ends longitudinal I-beams which support the inner edges of the surface platforms. The outer edge of these platfoms are carried on I-beam girders blocked up on the bottoms of trenches at the curbs. The earth between drifts is then removed and the needle beam shores are reinforced by jack screws resting on continuous longitudinal sills. The posts are then set in shafts, and when completed replace the jack screws and blocking as supports for the needle beams and street platforms. The arrangement described is indicated by Fig. 8.

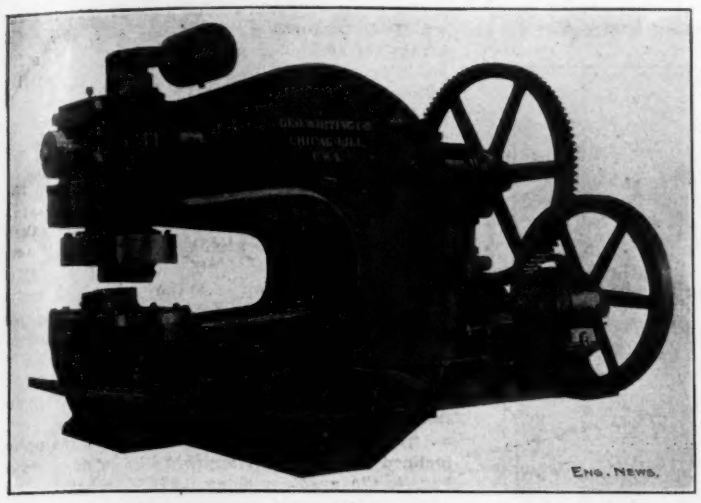


FIG. 1. SHEARING MACHINE WITH TURRET HEADS FOR ADJUSTING THE KNIVES.
Geo. Whiting Co., Chicago; Makers.

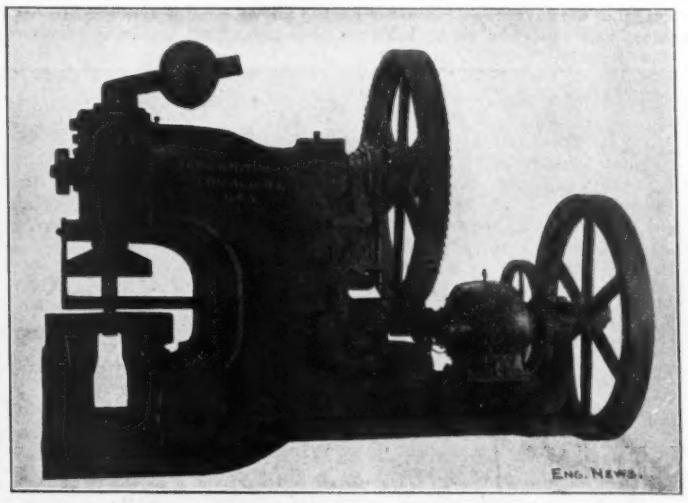


FIG. 2. COPING MACHINE, WITH ATTACHMENT FOR PUNCHING THE FLANGES OF 6-IN. I-BEAMS.
Geo. Whiting Co., Chicago; Makers.

TWO NEW MACHINE TOOLS FOR WORKING STEEL PLATE AND STRUCTURAL SHAPES.

Two new machines for shearing and punching plates and shapes are described below, both of them being built by the Geo. Whiting Co., 428 N. Halstead St., Chicago, and the particular machines mentioned were built for the John A. Mead Mfg. Co.'s works at Grand Crossing, Chicago.

Fig. 3. Coping Machine, with Attachment for Punching the Webs of 24-in. I-Beams.

The first of these machines is a shearing machine designed for plate or sheet work, and having the knives adjustable, so that they can be set parallel with or at any angle to the line of the throat. In this way the machine may be used as a splitting or cross-cut shear, or as a gate shear. As the knives can be readily shifted to any desired angle, large plates may be cut without swinging them around, and sketch plates may be cut with less than the usual amount of waste.

It will be seen that the machine is in general similar to any ordinary heavy shear, with the exception of the knife attachments. The upper sliding head and the lower jaw are both fitted with shear blocks or turrets, which can be revolved and set at any position. The blocks revolve on a common center, and by lowering the sliding head till the knives are in contact, both blocks can be turned simultaneously and the knives kept in proper relation to one another. The side of each block is graduated and an index mark on the bed enables them to be set quickly at any desired angle. The machine illustrated has a throat 48 ins. deep, with knives making a 24-in. cut at each stroke. In Fig. 1 the knives are shown set at an angle of 45° with the throat, for shearing sketch plates, etc. For shearing universal plates or flat bars of any length they are set parallel with the throat, while for splitting plates they are set at right angles to the throat. This particular machine is driven by spur gearing from a 10-HP. motor of the Milwaukee Electric Co.'s make, mounted on a bracket bolted to the frame, but the machine is built in different sizes and may be driven by belt, electric motor or direct-connected steam engine.

The main frame is of extra heavy design, and the sliding head has a longer bearing than usual, to compensate for the extra length of blade. The slide is fitted with a bronze gib for taking up any slight wear. The clutch is of the positive-jaw type, attached to the shaft by two feathers, and the jaws are lined with plates of hardened tool steel. An automatic stop is used to stop the machine at any desired position of the stroke, and this device effects a positive disengagement of the clutch by means of an adjustable cast-steel cam ring on the clutch, with a roller of hardened tool steel on top of the stop plunger. Treadles for operating the stop are placed in front of the machine and at each side of the back of the throat, so that the machine is easily under control when large plates are being handled.

The second machine is a combined punch and shearing or coping machine for operating on rolled sections, and having special features in regard to the wide range and variety of work which can be done with it. It will cope and punch the flanges of 6-in. to 24-in. I-beams, and also punch the full width of the web of these and intermediate sizes. Fig. 2 is a view of the machine engaged in punching the flanges of a 6-in. I-beam. It will be seen that the lower jaw of the bed is cored out deep enough to admit a 24-in. I-beam, and is of such form as to allow the various structural shapes to be worked on the tools furnished with the machine. Fig. 3 shows the machine fitted for the maximum spacing of web punching in 24-in. I-beams. Fig. 4 is an end view, with a 6-in. and a 15-in. I-beam in position for coping, showing how work can be done on both sides of the machine.

The coping tools furnished provide for coping 6-in. to 24-in. 100-lb. beams, and this necessitates the use of two blocks in order to give the proper support for the larger size. The flange punching tools provide for punching one or two holes at a time in the flanges of beams or channels. For this work double blocks are used, having one end adapted for the 6-in. and the other for the 24-in. size, while adjustment of the blocks is provided for to suit the gage of different sections. Bevel top dies are used, conforming to the bevel of the flange, and are secured in holders of tool steel. Angles and Z-bars can be punched in either leg,

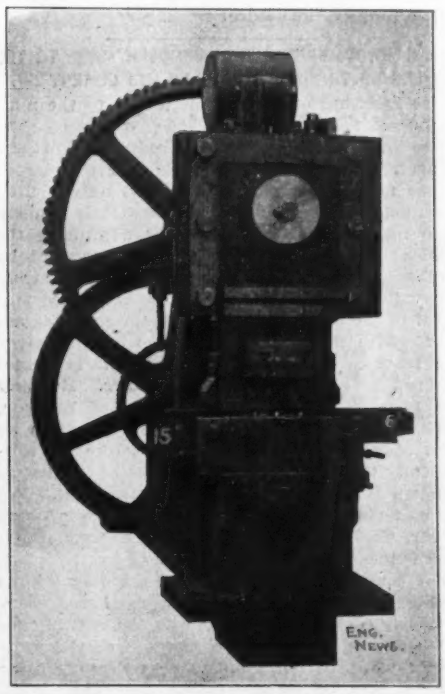


Fig. 4. End View of Coping Machine, with Blocks in Position for Coping 6-in. and 15-in. I-Beams.

and any kind of flanged work can be punched when the leg or flange does not exceed 24 ins. in depth. With the web-punching attachments, the machine can not only punch the webs of beams and channels, but also plates, angles and Z-bars. The punch and die holders are made of forged tool steel, and are adjustable, ranging from 2 ins. to 20 ins. c. to c. The die holders are made extra

high, so as to allow angles and Z-bars to be punched in either leg without turning the piece around.

The makers state that while they do not advocate the use of a machine fitted with a multiplicity of tools, yet it often occurs that concerns have not sufficient work to warrant the use of individual machines for different classes of structural work. In designing the several attachments for the above machine, this fact was taken into consideration, and the machine was made to take in a greater range of material than can be worked on ordinary machines. With these attachments the makers claim that this one machine practically covers the whole range of structural work.

FIG. 1. DIPPER DREDGE FOR EXCAVATING MARL FOR THE BRONSON PORTLAND CEMENT WORKS.

CABLE HAULAGE FOR TRANSPORTING MARL TO THE MILLS OF THE BRONSON PORTLAND CEMENT CO.

The handling of the raw materials to the mills is in most cement works one of the chief items in the labor cost of producing Portland cement. This is more especially true where rock is the material employed, but it is only a little less true of works which make their cement from marl and clay. In American practice the marl and clay was nearly always excavated by mechanical means, some form of dredge or steam excavator being used. To get the excavated material to the mills, cars hauled by locomotives are used where the ground is solid enough to carry the trucks, otherwise the material is either pumped or else transported in scows. Recently the Bronson Portland Cement Co., of Bronson, Mich., has put in a cable haulage plant from its marl beds to its mills, which has worked so successfully that its description will be of interest to others having a similar condition to meet. For the material for their description we are indebted to Mr. G. E. Hayward, Manager, Bronson Portland Cement Co., Bronson, Mich.

The company named is one of the older of the Michigan cements plants using marl and clay. Formerly the marl was drawn to the mill in cars by means of horses. The increase of the company's plant to ten kilns made necessary some other means of transportation for the marl, which would provide sufficient quantities to insure steady and reliable supply of raw material. The system of drawing in cars by means of horses, and afterwards raising them by means of an elevator, was entirely inadequate. The marl deposits of the company are overlain by a layer of muck from 2 to 5 ft. in thickness, which being entirely composed of vegetable matter, made a rather precarious road-bed. This made the use of locomotive or electric motor impossible. As a considerable portion of the territory is covered by a growth of bushes and tamarack trees, the use of barges or scows would be attended with great difficulty in dredging out channels for free movement, and in keeping ice broken up in winter in narrow spaces. These difficulties would not occur in such great measure where an open lake is the source of supply. Accordingly the company arranged to install the cable haulage method, which a year's experience has proven to be very economical as well as successful means of moving the marl.

Fig 1 shows a new and powerful dipper dredge constructed this year especially for the excavation work by the Featherstone Foundry & Machine Co. This dredge excavates to a depth of 30 ft. below the surface and deposits the marl in steel dump cars of 1½ cu. yds. capacity, which are handled in trains of ten or more cars each.

FIG. 2. VIEW SHOWING ARRANGEMENT OF TRACK AND OF DREDGE CUTS IN EXCAVATING MARL.

The cars are "spotted" in the same manner as cars in a gravel pit, being controlled at will by a trip rider who, by means of a piece of steel, rings an electric signal gong in the engine room at the factory. The dredge, as shown, was working at a distance of three-quarters of a mile from the factory. The time consumed by loading ten cars is from six to ten minues. While the round trip to and from factory requires six minutes when that distance from the mill.

Fig. 2 shows the track and the excavation on one side, with the dredge in the distance. The width of the cut is 80 ft. and the depth is from 20 to 30 ft. This view shows two curves in the track. The manner of turning curves is shown in sketch Fig. 3.

The method of working is to excavate the full width of the dredge cut on one side, the track being laid as the work progresses. Then the full width is excavated on the other side, and, finally, by means of a float or barge made of oil barrels, to hold a train of empty cars, the space where track was laid is excavated, taking all the territory an entire width of 175 ft. for each track.

Fig. 4 shows a loaded train in transit, the trip rider being in the act of giving signal to start after the halt, while the photograph was taken. This view shows the steel cars which were made by the Atlas Car & Mfg. Co. of Cleveland, O. This train makes an average speed of twelve miles per hour, and is controlled at will by the electric signal. The rails weigh 35 lbs. to the yard, and the ties are the regular 8-ft. cedar or tamarack railroad ties. The haulage and tail ropes are ¾-in. plow steel cable, and the signal line is of No. 12 galvanized fence wire.

At the mill end of the line the track leads up an inclined trestle which appears in the distance in Fig. 4, the gradient being 6.37%, and at the top of which is a landing sufficient for twelve cars, a portion of which descends toward the mill on a 1% grade. Alongside this landing is a siding which holds the empty train. The track turns sharply to the left, passing into the building directly over six marl tanks of about 120 cu. yds. capacity each, and the cars after landing are drawn into the building by a separate tail rope cable operated by two friction wheels controlled by a shifting lever and brake. When the trip lands, the tail rope is disengaged quickly and immediately attached to the empty train, the short tail rope cable being attached at the same time. The haulage rope is likewise transferred and the empty trip pulls out without delay and spring poles close the switches automatically. The two men who look after the dumping of the cars are immediately able to draw the cars into the building, stopping at either or both of the two stone separating pug mills, where the cars are dumped by friction drawn rope, and the cars are washed out by water jet or hose with quick opening valve. After the train has passed in a sufficient distance to dump all the cars, the spring switch closes behind them and by throwing the rear short cable around a sheave in the side track, the trip is easily and quickly backed into the siding and the process is repeated without uncoupling any cars at all. The trip rider is never permitted to ascend the trestle without hand signal from the men who dump the cars and handle the empty

trip or train. The side track is somewhat lower than the main track, with a "hump" near the outgoing end to insure against the empty train escaping control and running out on the incline. Fig. 3 is a sketch of track arrangement. The haulage engine is located in the main engine room of the factory. The engineer is unable to see the "trip" when it "lands," owing to special circumstances, and a double set of signal wires and bells are used when that event takes place. The trip or train rider being required to apply his steel to each quickly to guard against failure of one signal bell to sound at this critical moment. In this

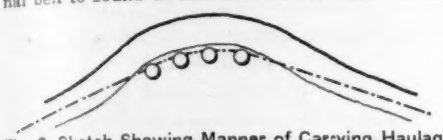


Fig. 3. Sketch Showing Manner of Carrying Haulage Rope Around Curves.

way accident is avoided and very little trouble has been experienced. The engine is a Mansfield double 10 × 16-in. cylinder, geared engine. The amount of cable used is 5,500 ft. of haul rope and 11,000 ft. of tail rope.

The number of men required to operate this department is as follows: Dredge crew, 3 men; trip rider, 1; track cleaner, 1; dump men, 2. In addition, a force of men is called in occasionally to lay track or take up track. Their time will average about 1½ times the constant services of one man.

The capacity of this outfit at this distance is about 30 cars per hour, and as the cars are usually "heaped up" somewhat, the hourly capacity is about 50 cu. yds. of marl, which is afterward increased by addition of water to insure handling by pumps. The cost per barrel of cement is 4 cts., average, for placing the marl in tanks ready for chemical analysis. This cost includes labor on track and all expense of maintenance. This system would apply equally well to hauling dry materials, but it meets the special requirements of this place, since there being no grit or stone, the cable wears but little, although wood rollers are kept in good order for the part drawn in track and iron sheaves for the portion away from track. Undulations in track and sharp curves are no particular obstacle, and a considerable rate of speed, sometimes 14 miles per hour, can be maintained, which insures prompt delivery of material. Only two trains of ten cars each are used, although four more cars are available. This cable line has traveled more than 7,000 miles distance and delivered more than 60,000 cars of material in eight months without a derailment of any consequence.

ANNUAL CONVENTION OF THE INDIANA ENGINEERING SOCIETY.

The 24th annual convention of this Society was held at Indianapolis, Jan. 14, 15 and 16; the meetings were held at the rooms of the Commercial Club, and the headquarters were at the Hotel

FIG. 5. SKETCH SHOWING TRACK ARRANGEMENT AT MILLS.

English. At the opening meeting in the afternoon of Jan. 14, there was an address by the President. Prof. R. L. Sackett, and a report from the Secretary, Mr. C. C. Brown; the latter showed that the Society now has 111 members. The report of the Committee on Roads and Pavements, by Mr. J. S. Humphreys, dealt mainly with the sanitary aspects of the paving question, in regard to dust, etc. A paper on "The Indianapolis Municipal Testing Laboratory" was read by Mr. Walter Buehler, Assistant City Engineer. An abstract of the paper is printed elsewhere in this issue. Prof. W. K. Hatt then presented the report of the Committee on Materials of Construction, and a paper on "The Theory of Concrete," by Mr. S. B. Newberry, was read by the Secretary. Prof. W. D. Pence, of the Committee on Bridges and Masonry, then presented some specifications of bridge masonry, which were followed by considerable discussion as to the respective values of dry, wet and medium concrete, the permissible percentage of dirt in sand, and the formation of smooth concrete surfaces.

CONCRETE.

The paper by Mr. Newberry stated that most competent engineers now use crushed stone without screening, but with all the dust from the crusher. He believes good quartz gravel is better than stone, as it is harder (except for trap or quartzite), and its rounded form leaves less voids. There is no ground for belief that rounded stone or sand makes concrete of less strength than that made with angular material. The proportion of voids is a matter of great importance, and he thought insufficient attention is given to the influense of proportions on density, and of density upon strength. He believed that the strength of concrete is proportioned to the ratio of the percentage of cement to voids, and that mixtures in which the voids are filled to the same degree will be approximately equal in strength. Another factor is the amount of surface, as all surfaces must be coated with a film of cement to produce adhesion, and the greater the surface the greater the quantity of cement. It is chiefly for this reason that coarse materials give a greater strength than fine materials. Machine-mixing was recommended, with the sand and cement first mixed, then the water added, and finally the stone or gravel, which should be previously well wetted. Freezing does no harm in Portland cement concrete after the mass has fully set; the hardening is interrupted, but proceeds again without hindrance after thawing. Damage is to be feared from frost before setting, especially if excess of water is used.

At the evening session, the report of the Committee on Architecture was first presented, and dealt with the 16-story Ingalls office building at Cincinnati, a full description of which was published in our issue of July 30, 1903. Mr. C. A Kenyon, of the Hoosier Construction Co., then read a paper on "Bituminous Macadam and Ordinary Macadam," which was illustrated by numerous stereopticon views of streets paved with the bitulithic pavement. After this, Mr. C. H. Hurd, Consulting Engineer for the Indianapolis Water Co., described some efficiency tests of fuel made at the company's pumping station, which was visited the next day. Pulverized coal made from the cheapest mine refuse, and ground in a ball and tube mill, is blown into the furnace with an air pressure of about 2 ounces. The temperature at the burners is about 3,000°, which is reduced to 400° at the breeching. The boiler is rated at 200 HP., but is delivering 250 HP. regularly. The session concluded with a talk by Prof. W. K. Hatt on "Structural Timber." He gave particular attention to the gum woods found along the Atlantic coast and in the Mississippi Valley, and explained that it is a mistake to assume that the strength of timber is affected by "sap stains" or by bleeding the timber for turpentine.

FIG. 4. VIEW OF TRAIN LOADED WITH MARL EN ROUTE TO MILLS.

On Jan. 15 the first session was called to order about 9.30 a. m., when the secretary read a paper by Mr. A. J. Hammond, City Engineer of South Bend, Ind.

A NEW WOODEN TRUSS BRIDGE.

This is a highway bridge over the St. Joseph River, between South Bend and Mishawaka, built in 1903, and consists of six spans of 72 ft. on cylinder piers. The trusses are 10 ft. depth, and both the length and depth allow of the use of regular mill sizes of timber. The top chords are built up of planks 2½ × 12 ins., 12 and 18 ft. long, while the web members and bottom chords are of planks 2 × 10 ins., 12 ft. long, put together with oak pines. The truss is figured as a girder, the web taking only shear, and the chords taking all bending moment. The estimated cost worked out at $14.84 per ft., but the contract price worked out at only $11.54 per ft.

A paper on "Steam Heating from a Central Station" was then read by Mr. F. B. Hofft. Following this Mr. Chas. H. Hills presented a paper on "Power Transmission Chains." He did not deal with cast chains, but described the different forms of machine-made chains with blocks and rollers. The sprocket wheels are often the weak point of chain transmission, as the tendency is to use small sprockets, which are easier to make and cheaper in first cost. No sprocket should be used having less than 12 teeth, but many makers use them with only 8 or 9 teeth, and some with only 5 teeth. The chains should be properly cared for and kept clean, and for lubrication a mixture of oil and graphite is preferable to dry graphite.

A short paper on "Smoke Prevention," by Mr. R. P. King, reviewed various devices and methods,

and presented the conclusion that the mechanical stoker is the solution of the smoke problem. The secretary then read a short paper by Prof. W. F. M. Goss on "The Plans for Testing Locomotives at the Louisiana Purchase Exhibition." These plans have already been fully dealt with in our columns.

THE RELATION OF THE RAILWAY PROFILE TO LOCOMOTIVE POWER.

This paper was by Prof. Wm. D. Pence, and some notes from it are given below:

The difference between the operating profile and the actual profile is very commonly ignored by railway civil engineers. This is in part due to the fact that the civil engineer is frequently unfamiliar with the fundamentals connected with the operation of locomotives and trains over the line which he locates and builds, and perhaps maintains, and which he is called upon to revise and improve. The trouble is that the civil engineer has often been so occupied with the construction or "pick and shovel" part of the problem, that the operation or "locomotive" part of it receives little attention. In other words, the "haul" that he has in mind in locating and building the line is that of earthwork yardage from cut to fill, rather than that of trains over the finished line. But the civil engineer who locates and builds the road and improves its grades should have more than a mere superficial knowledge as to the operating ability of the locomotives which are to haul trains over the line. The entire practicability, as well as the business sense, in natural co-operation of this sort is fully evidenced by the splendid economies accomplished on some roads under such a system.

The term "operating profile" may refer to either freight or passenger service. Generally, however, the ruling or critical conditions, are imposed by freight service, and it is customary to discuss the profile first on that basis; afterwards testing doubtful portions, perhaps, with reference to pasenger train conditions. Two general steps are involved: 1. The determination of the tonnage of the train which the given locomotive can steadily pull up an assumed or prescribed maximum grade of indefinite length, at a maximum speed of say 7 or 10 miles an hour, which speed is intended to give a slight margin above the stalling conditions. 2. To test the operation of this train under all conditions of service, from starting at stations or elsewhere, to the maximum speeds in sags and on large grades.

STREAM POLLUTION.

At the afternoon session the report of the Committee on Stream Pollution was read by Mr. A. J. Hammond. It stated that farmers have won suits where refuse has rendered water unfit for animals to drink. This tends to keep the subject alive and to force the government and the factory owners to realize that the problem of abating the nuisance must be met. Special studies will be made at Lafayette on Wabash River water before and after the starting of a strawboard factory, and studies as to the effects of sewage pollution will also be made. The Secretary then read a paper by Mr. M. O. Leighton, of the U. S. Geological Survey, on "Stream Pollution in Indiana, with Special Reference to the Purification of Strawboard Refuse." Mr. Leighton is in favor of a policy of persuasion and education of the strawboard interests, and claimed that the practical results of this policy during the past year have been far greater than the results obtained by years of hostile litigation.

The discussion was opened by Professor Hoffman, who referred specially to the case of Anderson, where the river is polluted by strawboard refuse, slaughter-house refuse and the waste acids from tin-plate mills and rod mills. These acids, however, are of comparatively little importance. Dr. J. N. Hurty, Secretary of the State Board of Health, spoke at considerable length, and while he scored the strawboard interests for the pollution which their factories cause, he pointed out other serious offenders. The city of Indianapolis is the worst of these, and the condition of the river at this city is indescribably foul as well as very dangerous. The river has a series of pools and shoals, or "ripples," and these holes contain thick beds of sewage, being, in fact, a series of septic tanks, with the result that in many places fish cannot live in the water. He favored government action to compel the establishment of improved methods, as he did not think the city would ever undertake any improvement without such outside pressure. Besides the cities, the farmers are largely responsible for pollution, and particularly for the spread of hog cholera. Prof. Severance Burrage also spoke as to the farmers' responsibility in this matter. On the river above Princeton, Ind., the conditions are such that it needs only a case of typhoid fever on the drainage area to cause an epidemic at Princeton similar to those at Butler, Pa., and Ithaca, N. Y. Professor Sackett, of Earlham College, referred to the experiments made at that institution with the chemical treatment of the strawboard refuse, which contains lime and finely-divided straw, for which no use has yet been found. The process of manufacture is wasteful in the extreme, there being 25 tons of refuse material to every 50 tons of straw used. With better methods this amount of waste would be less, and the expense of treating this waste also less in consequence.

At a later meeting a resolution was passed to the following effect:

Whereas public water supplies now receive sewage and industrial wastes, and whereas the Supreme Court has decided that cities and towns have the right to discharge sewage into streams: Resolved, 1, That the society recognizes that present conditions cannot be remedied under the present laws, and recommends speedy special legislation; 2, That public water supplies should always be filtered, as accidental pollution is likely to occur at any time, no matter what care is taken to prevent pollution by cities, towns and industries.

SEWERAGE AND SEWAGE DISPOSAL.

The papers on these subjects were next taken up, the first being on "The Sewerage System of Connersville, Ind," by Mr. K. L. Hanson, City Engineer. This city has a population of 10,000, and has the combined and separate system of sewerage in different districts, according to the needs of these districts. Mr. C. C. Brown was consulting engineer. A paper on "Sewerage and Sewage Disposal at Bedford, Ind.," was then read by Mr. G. C. Houston, City Engineer. This place has the separate system, with 8-in. laterals. An inverted siphon of cast-iron pipe carries the sewer across a ravine. There is a septic tank 75 × 20 ft., in which the sewage is 9 ft. deep. Prof. R. L. Sackett followed with a paper on "The Septic Tank and Filter Bed of the Eastern Indiana Hospital for the Insane." This plant has to take care of laundry and bath water as well as sewage from 800 people. Disinfectants and the torn clothing which patients throw in the closets are disturbing elements. The septic tank is 48 × 16 ft., 10 ft. deep, with 6 to 8½ ft. head. There is a distributing or receiving chamber, and a dosing chamber, which discharges when the contents reach 4,000 gallons. The tank is of concrete, reinforced with old wire rope. The effluent filter beds have a grillage of farm tile, covered with 6 ins. of coarse gravel and 3 ins. of unscreened bank gravel varying from fine sand to 1½-in. stones. In the evening Mr. W. S. Shields, of Chicago, read a paper on "Filters Versus Contact Beds in Sewage Purification," illustrated by stereopticon views.

The other papers presented at the evening session dealt with mechanical engineering, and were all illustrated by stereopticon views. Mr. F. F. Chandler described a new automatic stationary engine of the Chandler & Taylor Co., which is built both single and tandem compound. Prof. J. D. Hoffman described the new central power and heating plant of Purdue University, together with the distribution system of piping and conduits. The last paper was by Mr. G. A. Young on "The De Laval Steam Turbine." There was no discussion on any of these papers.

At the last session, on Saturday morning, Jan. 16, four papers on electric and interurban railways were read: "Interurban Railways in Small Cities," by Mr. J. W. Fulwider; this discussed the questions of franchise, construction and operation, and recommended T-rails not less than 6 ins. high. 2. "Statistics of Indiana Interurban Railways," by R. P. Woods; this was a tabular arrangement of statistics as to the physical conditions, equipment, power plant, etc., and was read by title. 3. "Steam and Electric Railways and Their Relations to the Public," by A. Shane; this was a comparison of statistics as to traffic, finances, wages, operation, etc. 4. "Some Special Street Railway Work," by T. B. McMath; this described some very complicated work for the intersection and junction of lines at points where ordinary street cars and very long interurban cars have to be provided for. After a brief discussion, a series of resolutions of thanks was adopted, and the convention adjourned.

OFFICERS AND PLACE OF MEETING.

The officers elected for the coming year are as follows: President, Prof. R. L. Sackett, Earlham College; Vice-President, J. B. Nelson, Indianapolis; Trustees, R. P. Woods and J. H. Fulwider; Secretary, C. C. Brown. The next meeting will be held at Indianapolis in January, 1905. It was voted that steps should be taken to affiliate in some way with the new Indianapolis Engineering Club, which is now being organized.

THE USE OF CONCRETE BLOCKS IN MANHOLE CONSTRUCTION.

By Hugh C. Baker, Jr.*

The latest type of manhole construction used for subways for electrical cables is known as the concrete block manhole. The New York Telephone Co. has just completed a large amount of subway construction in the towns and villages near New York city, and having in the past experienced great difficulty in securing the right kind of skilled labor just when required for the work of building brick manholes, it was felt that if the cost of manhole construction could be reduced by substituting concrete and ordinary labor for brick and itinerant skilled labor, and if concrete manholes could be built which would be better in every way than the brick manholes, the experiment would be worth trying.

The use of concrete in manhole construction is not new. For the past four or five years a number of companies using subways for their cables and wires have built concrete manholes in most of the large cities in this country. The general practice has been to set up in the excavation a sectional mold of the same size and shape as the inside of the manhole and fill in around this mold with concrete to form the walls, the sides of the excavation forming the outer mold. After the concrete had set about 24 hours it was possible to remove the mold and use it in another manhole. The top is made of solid concrete, re-enforced with I-beams or expanded metal, or both. A large number of manholes of this kind have been recently built in New York city and vicinity, and as no skilled labor is required the cost is from $4 to $25 less than if brick were used, depending on the size of the manhole and the existing conditions.

The greatest objection to this solid concrete manhole is that in most cases, especially where rock has been removed or in running sand, it is impossible to confine the sides of the excavation to the proper dimensions, and so a large amount of the concrete which is placed around the interior mold is wasted.

Other objections to the solid concrete manholes are that the walls and top crack; that if the grade of the street should be changed, necessitating the raising or lowering of the iron cover to any extent, as is often the case, it becomes necessary to break up the top and a part of the walls and rebuild at a different level; the old concrete going to waste.

Having learned from experience the disadvantages of brick and solid concrete manholes as applied to telephone subway construction, the concrete block manhole was designed and developed by the Construction Department of the New York Telephone Co., in order to produce a manhole which would combine all the good points of manholes previously constructed without the disadvantages. The walls of the block manhole as now used are made up of a number of horizontal layers or rings of concrete blocks of two different shapes. The arrangement of the blocks as well as their comparative size and shape and the dimensions of the manholes recently built are shown by Fig. 1.

The sectional plan (Fig. 1) shows that the radii of the side and end curves of the walls are of the same length; also, that the radii of the curves forming the corners are of the same length. For this reason, assuming that the bottom ring of blocks forming a part of the walls is shown by the full lines in the sectional plan (Fig. 1), if the short blocks are reversed, i. e., turned upside

*Engineer of Subway Construction for the New York Telephone Co., New York City.

down, in the second ring and the long blocks put in place, all of the blocks in this ring will be in the position shown by the dotted lines. By doing this the joints are broken or staggered, as shown in Section a b. The third layer of blocks is laid in a manner similar to the first layer, and so on, for as many layers as may be necessary to make up the required height of the manhole.

In the manhole illustrated five layers are used. There are, therefore, 30 blocks in the walls,

	Set of 6 top blocks.	Set of 30 wall blocks.
Weight, lbs.	1,853	9,447
Concrete, cu. ft.	13	67
Cost of making blocks*	$4.27	$21.00
" " I-beams, in place	5.40	.....
" " blocks in place.†	6.00	32.00
Time to put in place, ordinary labor	3 man-hrs.	20 man-hrs.

*Not including cost of molds.
†Not including freight.

The total average cost of complete manhole, without iron cover, was $43.40.

The comparative cost of a brick manhole of similar size and shape, covered with the flat concrete top, as actually built, was as follows:

Brick, 1,450 at $8.25 per M	$11.96
Mason	6.00
Labor, 46 man-hours at 15 cts.	6.90
Cement, 4 bbls. at $1.25	5.00
Sand	.75
Supervision, etc.	2.50
Set of six top blocks in place, and I-beams, in place	11.40
Total	$44.51

The cost of excavation has been left out, as it is practically the same in each case.

The above figures are approximate, as they represent the actual average cost of a number of manohles.

In making the block manholes a complete set of thirty wooden wall molds was used. All concrete was hand-mixed and proportioned, as follows: 1 part Atlas Portland cement, 2 parts sand, 5 parts ¾-in. machine-crushed trap rock. Concrete was placed in the molds very wet, with little tamping. With the facilities at hand six complete sets of top blocks were made each day with four men, when no wall blocks were being made, and half a set (15) of wall blocks and two sets of top blocks were made each day with four men. The concrete was allowed to set from 3 to 12 hours before the molds were removed, and always from 24 to 36 hours before the blocks were taken outside to dry. All blocks were allowed to set for seven days or more, before being transported and placed in the ground. The wooden molds were made by a local carpenter at a cost of from $3.50 to $12 each; some of them were made partly of hard wood, zinc lined.

Fig. 2 shows the blocks in the ground as used for manholes. In all nearly 1,000 separate concrete blocks were made in the barn and only about nine were lost by breaking.

In making the duct entrance to these manholes, the blocks were cut away where necessary and cement mortar used to finish around the ducts. All of the blocks used were unnecessarily heavy, as will be seen by the illustrations, the idea of the experiment being to determine whether or not this form of manhole would be an improvement on the old solid concrete manholes.

For this reason, the simplest form of construction was tried. As the construction of this block manhole is now considered to be advantageous in so many ways, experiments are being made with semi-hollow blocks and with flanged blocks, and next year it is believed that a large number of these manholes will be constructed.

The writer is the originator of the "concrete block manhole," as described, and has secured a patent on one form of construction and several other patents on other forms are now pending.

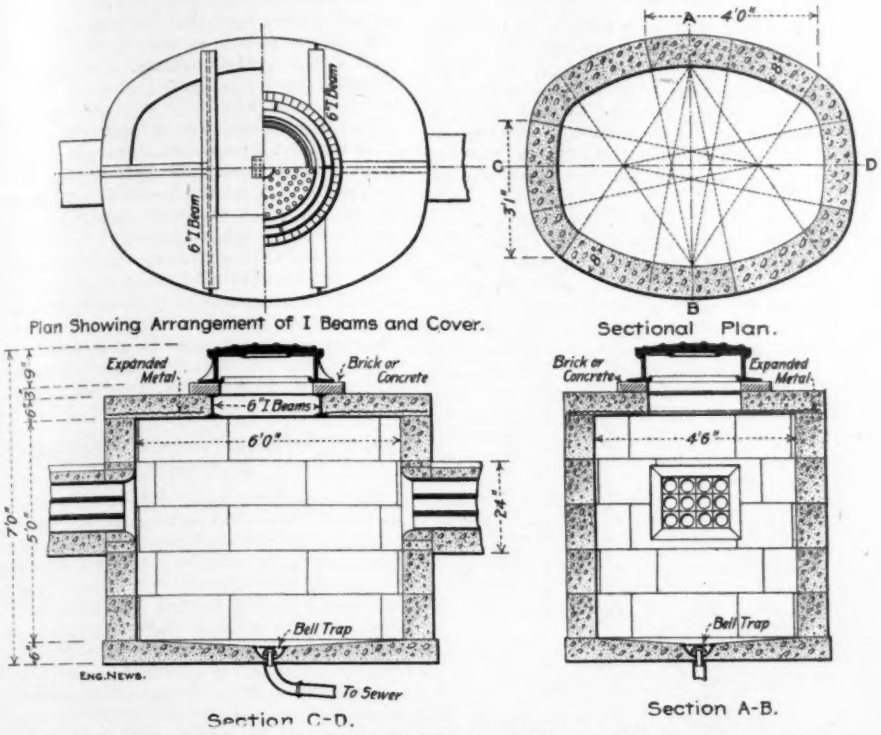


FIG. 1. CONCRETE BLOCK MANHOLES BUILT BY THE NEW YORK TELEPHONE CO.

DRAFT IN ASH PANS.*

By S. Shepard.†

While the evolution of the locomotive during the past decade has been marvelous, it occurs to me that one point of improvement has degenerated, viz., to maintain proper draft in ash pans. There is a marked increase in the cost of maintenance of recently designed engines, directly chargeable to the short existence of their side sheets and flues, and in my opinion the most prominent cause of leaks inside a fire-box is brought about by improper arrangement of draft in ash pans.

Practical engineers will agree with me that a few years ago when we ran nothing but 17 × 24-in. cylinders with fire-boxes containing 16 sq. ft. of grate surface, with ash pans containing 21 cu. ft. of air and 5 sq. ft. of damper opening always at the end of the pan, with the rotary damper in the fire-box door, we had more perfect combustion, more uniform maximum steam pressure and fewer leaky flues and side sheets than we do with engines of the present day. I ask the question why was this; and answer it by saying that to-day we have our engines drafted improperly through the ash pan. To-day we are running engines with 40, and even 50 sq. ft. of grate surface with only 6 sq. ft. of damper opening in their ash pans; and the cubic air space of some of the present pans has been cut down as low as 30 ft. The damper openings are cut along the sides of the pan, the air drawn through these openings passes through the grates to the flues unevenly, leaving the center of the grate

Fig. 2. View of Concrete Block Manhole Under Construction.

surface unsupplied, and being directly under the side sheets causes them to be continuously exposed to the rush of cold air. The side damper openings being covered with screens, collect the grease from the driving boxes, the dirt and snow from the roadbed, and consequently the limited damper opening becomes still less until an insufficient amount of air is furnished, and the constant pull on the sheets and flues results in leaks and cracks. We want some one to build a locomotive with an ash pan containing as many cubic feet of air as there are square feet of grate surface, with no less than 7 sq. ft. of damper opening to a 50-ft. grate surface, all this opening to be in back end of pan. Then the air will pass through the grates evenly, will be hot when it reaches the flues, and a point will be gained in modern construction of ash pans.

*A paper read before the Northwest Railway Club.
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Two weeks ago, in commenting on the Iroquois Theater holocaust, we said that its occurrence should prove a strong argument for safer construction of all places of public assembly, and should serve as a warning to communities all over the country to look well after their public buildings and guard against such disasters at that at Chicago.

To a marvelous extent, this has actually happened. We do not now recall any instance where the lesson taught by a great disaster has been so promptly and so widely heeded. In hundreds of towns and cities, large and small, in every part of the country, we hear of commissions at work investigating the safety of existing theaters, churches and public halls, and everywhere radical improvements are being made in the provision of safer and more adequate exits, means of extinguishing fire, safeguarding of heating and lighting apparatus, and, in general, of all points that have to do with the safety of an audience from panic or fire.

Of course this attitude will not last. Public attention will shortly be diverted in other directions and municipal ordinances regarding safe construction and management of theaters and similar buildings will be observed in a more or less desultory fashion as heretofore. Among architects and engineers, however, we believe the lesson will not so soon be forgotten. We risk little in saying that in architects' offices the provision of safe means of exit from places of public assembly will be given an importance in the future that it has not had in the past. It is, of course, the architect's business to see to this. He is as much in duty bound to make a theater or church or hall a safe building in this respect as he is to see that it is safe from the spread of sewer gas or safe from danger of collapse by reason of weak construction. The client may desire to economize at all possible points; but he will be likely to listen to reason if he is made to understand that human life is at stake and that neglect of precautions has had dire results in the past.

In this connection we have deemed it of interest at this time to publish an illustration and description of the recently completed Stadt-Theater at Berne, Switzerland, as a type of a modern European theater building. The contrast it presents to the typical American theater building is too obvious to call for extended comment. Of course the feature of most importance is the use of fireproof construction, whereas of existing places of public assembly in the United States as a whole, city and country alike, probably at least nine-tenths, and very likely a much larger proportion, are of ordinary wooden or "fire-trap" construction Not until these old structures have been replaced with fireproof buildings will the first essential toward the safety of public audiences in this country be secured.

The sudden death of an inspector upon emerging from a caisson of the Manhattan Bridge has called public attention in New York city to the danger attending such work as now conducted. This death has been preceded by the deaths of four laborers upon the same work; and, now that the work is nearly completed, the Board of Health has been roused to investigate the cause and the possible remedy.

In our issue of Sept. 5, 1901, the occurrence and treatment of caisson disease were discussed at length, and we do not purpose repeating what was then said further than to call attention to the fact that caisson work in this country has been done at the expense of far too many lives. A brief summary of the loss of life on some of the important works where compressed air has been used may serve to emphasize the danger.

In the East River Gas Tunnel, where the greatest depth below water was 120 ft., there were four deaths among the 15 men who suffered from the "bends," and this in spite of the fact that all workmen underwent a careful physical examination before admission to the air lock.

On the Eads Bridge, at St. Louis, Mo., a depth of 110 ft. was reached at the cost of eight lives. There were 77 cases of caisson disease on this work, in spite of physical examinations and the use of stimulants.

On the Brooklyn Bridge work, where the maximum air pressure was 36 lbs., there were three deaths out of 110 cases of the "bends," of which 10 were so serious as to be accompanied by paralysis.

On the Williamsburg Bridge, just completed over the East River, New York, although a depth of 100 ft. was reached, only a few mild cases of caisson disease were developed. The only precautionary measures used were to provide a warm room, baths for the men upon leaving the caisson, and to supply them with plenty of strong coffee.

Including the Manhattan Bridge, now under way, we have a record of 20 deaths on five large contracts involving the use of compressed air at great depths. Taking no account of the suffering and physical injury to some hundreds of workers, this is a record that deserves the serious consideration of engineers and contractors. Cannot the number of deaths and the suffering on future work of this character be lessened? and if so, how?

In this issue we publish an illustrated article descriptive of the automatic air valves used in caisson work on the dry-docks at Kiel, Germany. The object of such a valve is to make it impossible for workmen to pass through the air lock in so short a time as to cause serious risk of injury as is now the common practice in this country. The automatic valve is so constructed that after entering the lock from above the men cannot leave it for a period of 20 minutes, during which time the air pressure is gradually increasing until it equals the pressure in the working chamber below. In coming out of the working chamber the men remain in the air lock for 40 minutes, during which time the pressure is gradually reduced until it equals that of the atmosphere. It is a well-known fact that rapid locking out is far more injurious to the men than locking in, hence the difference in time at which the automatic valves are set to work.

If each man works two shifts a day it is obvious that two hours are daily lost in locking in and out; but is not the purchase of good health and safety worth the price? The men, it is true, will not voluntarily submit to so much "lost" time, hence the necessity of some such automatic device that is beyond the control of those in the lock. The contractor will not voluntarily use a safety device that the men themselves would object to, hence the necessity of prescribing the device in specifications if it is to be used at all. This is in fact the nib of our argument. Engineers who have the drawing of specifications for deep compressed air work should specify for one thing, a minimum time to be consumed in locking in and out. If the engineer has neglected to do so, looking upon the handling of the men as beyond his province, then the Board of Health appears to be the only authority that can compel action to insure the safety and well-being of the men.

We have not spoken of the treatment that men should receive once they show symptoms of caisson disease, but among the most rational and thus far the most effective, is a compressed air hospital, which is in fact a small air lock into which the patient is placed, and left under air pressure until the pains subside. This "hospital" might well be required in the specifications for caisson work where high pressures are to be used, in view of the practical certainty that there will be a number of sufferers from the "bends" regardless of every precaution.

In closing this brief summary, we may add that were such precautions taken, as have been suggested, they would in all probability so reduce the suffering and the mortality as to reduce the rates of wages now demanded by workers in compressed air, and thus eventually reduce the cost of engineering structures involving caisson work.

THE RESPONSIBILITY FOR CONTROLLING THE SPREAD OF TYPHOID FEVER.

In the present state of sanitary science, some one is at fault if the average yearly mortality from typhoid fever exceeds 20 per 100,000 of population. This fact the public generally does not recognize, but the day will come when it will not only recognize it, but also insist on a lower limit. In the present state of public opinion on epidemic at rare intervals of time and space will put a community in a ferment and cause widespread alarm, while a continuing annual typhoid mortality of 50 to 100 per 100,000 in some scores of cities and towns scarcely receives a passing comment.

Epidemic typhoid results in a public demand for placing the responsibility on some one's shoulders, while endemic typhoid generally continues year in and out with at best only a few ineffectual protests from some sanitary engineer or progressive physician.

Upon whom does the responsibility for the prevention of typhoid fever, whether epidemic or endemic, rest? First, upon the people as a whole; second, upon their representatives in city and state governments; third, upon the purveyors of water and milk.

Before proceeding to a more detailed consideration of questions of responsibility, a few brief statements will be made as to the cause and transmission of typhoid fever. If these seem elementary to some, they or the lessons they teach are none the less needed by hosts of others.

Typhoid fever is caused by a parasitic vegetable organism, whose natural habitat is man. The discharges from the intestines and bladder of typhoid fever patients teem with innumerable millions of the typhoid bacillus or germs. Every case of typhoid fever is due to infection from some previous case, often through long and devious channels, remote in time and space. Man is the center of infection, and the destruction of the infectious material from each typhoid patient is the only safe procedure. If only for a few years each and every successive case could be diagnosed and controlled, typhoid fever would soon be eradicated from the face of the globe. This would follow as certainly as would the disappearance of wheat or any other higher form of plant life if only every kernel of the grain in question were to be destroyed.

As a practical matter, we cannot destroy all typhoid germs, but intelligent, unremitting attack on endemic centers and scientific precautionary measures where epidemics are to be feared would soon decrease the typhoid mortality by from 50 to 90 per cent. in all communities where such attacks or measures are needed.

How is the disease spread from person to per-

son? First, by what is known as secondary infection, which results from improper care in handling the typhoid sick and from lack of complete disinfection of their stools, urine, and all linen and utensils soiled thereby. Such infection is confined more particularly to unskilled nurses and attendants, members of the immediate family of the patient, and laundresses who wash the linen of the patient. Secondly, the disease is spread through the contamination of food and drink, chiefly milk and water, by the typhoid-infected discharges from the bowels and bladder of persons sick with the disease. There is no hard and fast line between secondary infection, as defined, and the above-mentioned infection through food and drink. In general, secondary infection occurs within the household of some typhoid patient while all other infection is inflicted upon the public at large, whether in the immediate neighborhood or in some more or less remote community.

In an ideal civilization each head of a family and with him the attending physician and nurses would be at least morally responsible for such control of a typhoid patient as would make any infection therefrom an impossibility. This, however, would not hold true prior to the time that the disease had been recognized as typhoid, and therein will ever lie great danger until water, milk and other food supplies are universally protected with the utmost care.

As a practical question of the day, the responsibility for typhoid fever and its suppression is divided between the people, or society as a whole; their representatives, or state and local authorities; and the purveyors of water, milk and other foods. When a municipality owns and operates water-works it becomes doubly responsible for the water supply as a possible source of typhoid infection, since it is then both the representative of the people as a health protective authority and the agent of the people as a purveyor of a vital municipal supply.

The people choose their representatives, and through that fact and the force of public opinion they mold their form of government and all health-protective legislation. Upon the people as a whole, therefore, rests the primary responsibility for the suppression and prevention of typhoid fever. They should insist upon adequate health legislation and administration and should provide with ample hand the funds necessary for health work.

But while the primary responsibility of the people or society is unquestioned, it is nevertheless true that where representative government prevails, legislators are chosen to frame governments and laws, governors, boards and other officers to administer, and judges to interpret and enforce them, because society as a whole cannot do these things. It becomes the duty of these representatives of the people to ascertain and to enforce the best in the interests of all; and while a fountain cannot rise higher than its source, a member of a state legislature, or city council, of a state or municipal board of health, of a judicial body, or a governor or mayor, can and should recognize and act upon the fact that an office accepted from the people means responsibility, leadership and, finally, achievement for the people beyond what the rank and file could ever achieve for themselves. To be more specific, we may reasonably expect every progressive state, through its legislature, to make it the duty of every municipality to see that its citizens are provided with water and milk which are free from the germs of typhoid fever and other diseases. We may also expect every state to exercise such a supervision over local governments as to ensure obedience of its mandates, reinforcing weak municipalities by the superior knowledge and strength of its officials and holding the strong but negligent communities to their task. We may further expect the state to protect each of its local components from the evil effects of sanitary neglect in other towns and cities, such as the pollution of public water supplies and the production and sale of milk under insanitary conditions. Such protection may involve the sanitary inspection of sources of public water supply and of all dairies supplying milk or cream for home consumption.

The foundation of all health protective work is an efficient system of registration of vital statistics, including the reporting by physicians to a local officer every case of communicable disease within at least 24 hours of its diagnosis. It is incumbent upon state governments to establish such a system and to see that it is maintained at the highest possible degree of efficiency. Had such a system been in force at Ithaca and at Butler, to mention only two epidemic localities, the recent epidemics in those places would never have attained such proportions as they did, while had there been a proper system of reporting and caring for typhoid cases in the water supply drainage areas upon which Butler and Ithaca were dependent, neither epidemic would have occurred.

The duty of the municipality toward its water and milk supplies is in a sense greater, because more direct and immediate, than that of the state. Given the necessary legal authority by the state legislature, which, in fact, it rarely lacks within its own boundaries, and the city or town can keep typhoid fever at a minimum if only it has the will. If legal authority outside the municipal boundaries is lacking a vigorous crusade in the state legislature will generally secure the needed legislation against water pollution, but in the present state of public opinion securing control of outside milk supplies is more difficult. If the milk supply cannot be controlled the public can at least be kept fully informed as to its dangers. The same is also true of the water supply, but where legal control of this is lacking, engineering control, through the installation of water purification works, is entirely feasible. In fact, the time is rapidly approaching when all water supplies liable to pollution must be purified before they are delivered to consumers.

The actual purveyors of milk in our cities and towns are many, and their sanitary control, while quite feasible, is more or less difficult; but, as a rule, there is only one purveyor of water in each community. Systematic dairy inspection, combined with frequent bacterial analyses of milk, and publicity of the results of both inspection and analysis, will in a few years work a wonderful reform in the character of a city's milk supply, and greatly reduce the danger from epidemics of typhoid fever, scarlet fever and diphtheria, besides lessening endemic cases of those diseases and reducing the general, and in particular the infant, annual mortality.

Municipal sanitary control of a public water supply begins with the selection of the source of supply and continues through the design and construction of the works and their daily operation. It ends when to-day's supply reaches the consumer, only to begin again with the supply for to-morrow. It demands the best obtainable technical advice and supervision at every step. Above all, the character of the natural supply, its possible sources of pollution, and the means taken to stop the pollution or annul its possible consequences must ever be under the eye of the trained technical agent of the water purveyor and also of the municipal board of health. There may be cases, under municipal ownership, where the detailed sanitary supervision conducted by the water-works will be sufficient, but even then some general oversight or check may well be maintained by the health board. In fact, whichever municipal department undertakes to safeguard the supply should be checked by the other, but the greatest care should be taken to avoid the evil consequences so likely to occur under divided responsibility. Where private ownership prevails both the health and the legal departmnts of the city should keep the operations of the company under the strictest inspection, co-operating with the company to prevent pollution of the water by others and holding it strictly accountable for the purity of the supply. If the laws of the state are deficient in the protection of sources of supply, then the water must be purified at a point below the possibility of contamination, a rule which should likewise apply to works under municipal ownership.

Space forbids a detailed account of the methods to be employed in protecting public water supplies. It may be said, and of course the mere question of ownership of works has no bearing here, that the drainage areas of all surface supplies should first be cleared, so far as possible, of all sources of pollution, and if any habitations remain in the drainage area effective means should be provided to prevent the pollution of the water by human wastes. To ensure such measures sanitary patrol of drainage areas is essential. In case the prevention of water pollution is impracticable, on account of the size of the drainage area or the number of inhabitants thereon, the source of supply must either be abandoned or the water purified.

Frequent systematic analyses of samples of water should be made to supplement sanitary inspection and to check the results of purification works.

Medical inspection of the drainage areas of surface supplies has rarely if ever been adopted as a permanent measure, but under the conditions now affecting many water supplies its advisability might well be considered. The object of such inspection would be to detect and supervise cases of typhoid fever, in order to render impossible the infection of the water supply thereby. Such medical inspection would be less necessary where a proper system of reporting cases of typhoid fever prevails, but every one knows that even in the so-called registration states many cases of typhoid fever go unreported, and many more unrecognized in the rural sections, particularly in sparsely settled drainage areas.

A few words only can be said regarding the care of typhoid patients in such a manner as to restrict infection. In the first place, where cases of typhoid fever are promptly reported, no epidemic can steal upon a community like a thief in the night, as did those at Butler and Ithaca. Before even a hundred patients were down with typhoid, in places no larger than those named, any efficient board of health would have every case tabulated, including the sources of its water, milk and other food supplies, and, as a rule, the probable common source of infection would also be determined. While directing its energies against the source of primary infection, such a board of health would be guarding against the even greater dangers, which sometimes arise, of secondary infection. The attention to secondary infection required from a local board of health would depend very largely upon the character of the population and of the physicians and nurses at command. With competent physicians and nurses the dangers from secondary infection should be small, without any attention from the board of health. It should keep itself informed, however, about the character of the disinfectants employed and the intelligence with which they were being used. Should reports of two or more cases become frequent, an effort should be made to determine whether or not they were probably due to primary or to secondary infection, and if the latter was indicated then the methods aimed against secondary infection should be given closer attention.

In communities partly made up of a class of population that cannot afford proper medical attendance and good nurses, both should be supplied at public expense. In those rare cases where this would be beyond the financial ability of a city or town, the state should assume a part or all of the burden.

Before closing this necessarily partial review of the responsibility for typhoid fever, we wish to direct attention to three most important points, one of which has not been mentioned:

(1) Typhoid fever cannot be put down without prompt and complete notification of all cases by physicians to local boards of health, a rule which is particularly imperative and is now least observed in the rural sections of the country. To be really efficacious, local boards of health should promptly report all typhoid cases to the state board of health, in order that the cases may be correlated with the possible contamination of public water supplies and dairies.

(2) Water purveyors, whether municipal or private, are morally responsible for much of the typhoid fever in this country, and for most of the serious epidemics of that disease. It is highly desirable that the fullest possible legal responsibility for water-borne typhoid be determined, and

the differences, if any, between the legal responsibility of private water companies and municipal authorities controlling water-works be defined.

(3) Educational institutions, and particularly medical and engineering schools, should be made to feel their responsibility for the prevailing ignorance as to the causes of the spread of typhoid fever and other communicable diseases. This is a point which has not been mentioned in the foregoing review, and upon which we cannot now dwell, although it deserves most serious consideration. Neither the medical or the engineering schools are yet giving adequate, or with few exceptions, any really commendable instruction in the principles and practice of public hygiene.

LETTERS TO THE EDITOR.

A Question of Professional Ethics.

Sir: I wish to get together all the data I can bearing on the accepted ethics of the engineering profession. I am at the present time particularly interesting in learning the views of the editor and your correspondents upon the point of how much a man may be considered at liberty to practice his profession for persons who are not his regular employers, and in lines of work that his regular employers do not enter and do not seek to enter, but which by past experience and study he may be well fitted for. If you have within the last few years published anything bearing on this, kindly give me the date of issue and the page on which the article appears, and if you know of anything published on this subject in general I shall esteem it a favor if you will kindly inform me of it.

Yours truly, S. F. W.

Burlington, Ia., Jan. 12, 1904.

(We know of no published statement bearing upon the question cited by our correspondent. It would seem to us that the answer would depend on the nature of the "regular employment" referred to. It is very common for engineers holding positions paying a regular salary to accept outside consulting work. The privilege of doing this is a matter for personal adjustment between the parties concerned.—Ed.)

An Ingenious Method of Hauling Heavy Machinery Over Country Roads.

Sir: I enclose two photographs showing the method of moving heavy machinery over bad country roads, which may be of interest to some of your readers. The arrangement of the timbers and wagons is plainly shown by the photograph. The pilot wheel is mounted on planks spiked across the heavy timbers and the ropes lead to two sets of blocks which are fastened on the short tongue of the middle wagon. The generator field which is being hauled weighs 15 tons and was moved nine miles over rough and hilly roads in about six hours. We have also transported our 13-ton locomotives, complete, by means of this same apparatus. Yours truly,

C. E. Parsons,
Chief Engineer, Hudson River Water Power Co.

Glens Falls, N. Y., Jan. 6, 1904.

[The Spier Falls Dam of the Hudson River Water Power Co. was described in our issue of June 18, 1903, and a photograph was reproduced showing a 14-ton load on two wagons. The distributing of a 15-ton load, by means of trusses, over three wagons, is unprecedented so far as we know.—Ed.]

The Use of a Sand Jack for Placing the Shaft of the Battle Monument at West Point.

Sir: I have read with very great interest the article by Mr. Lincoln Bush, Chief Engineer, Delaware, Lackawanna & Western R. R., in your issue of Dec. 31, 1903, also your appreciative commendation of his successful use of sand jacks for lowering the Newark bridge. It perhaps will add one fact to the better understanding of "the distribution of pressure in granular masses" if the following experience is given.

In 1893 the shaft of the Battle Monument at West Point was lowered into place with the aid of a sand jack designed by the writer under the direction of Mr. O. W. Norcross. The shaft and casing weighed 90 tons, and in turning from a horizontal to a vertical position was landed on a granite post 2 ft. square, placed on a bed of sand in a pocket formed in the center of the masonry of the base. The bottom of the pocket was closed with an iron plate to which was fitted a 2-in. pipe with a gate valve. By experiment with the granite post it was found necessary to make the bottom of the pocket conical in shape with cement to secure uniform flow of the sand. The sand used was rather fine and thoroughly sun dried before being put into place. The weight of the shaft and casing settled the granite post ⅝-in., the load being 22½ tons per sq. ft. The ⅝-in. settlement of the post was the equivalent of 216 cu. ins. in a total volume of 16 cu. ft., making a reduction of volume of 0.78%.

From the data given in the article of Mr. Bush it may be noted that the settlement was a total of 1 in. for the full load of 2,815 lbs. per sq. ft. Comparing volumes, it will be found to equal a reduction of 0.77%, almost identical with the reduction in volume of the above instance, although the load per sq. ft. was only about one-sixteenth as great.

Most of the data of the West Point work will be found in Professor Charles W. Larned's book of the "History of the Battle Monument at West Point." The settlement of the granite post was observed by the superintendent in charge of the work, a very careful, accurate man.

Yours truly, Edw. F. Miner.

Worcester, Mass., Jan. 11, 1904.

A TRUSS ARRANGEMENT FOR CARRYING A FIFTEEN-TON LOAD ON THREE WAGONS; VIEW FROM THE FRONT.

VIEW OF LOADED WAGONS FROM REAR.

The Quality of Merchant Pipe.

Sir: I have followed with considerable interest the various articles appearing from time to time in the Engineering News with reference to the comparative resistance to corrosion of wrought-iron and steel pipe. I wish particularly to refer to your editorial remarks in the issue of Dec. 3, 1903. You there say:

Nevertheless, enough has been said to show that there is a good prospect of success for any firm which shall put upon the market a strictly high grade of wrought-iron plates and pipe, and build up a reputation for the excellence of its products.

I beg to call your attention to the fact that such a firm does exist for the manufacture of pipe and has been in operation for a number of years. The Reading Iron Co., of Reading, Pa., which is the largest pipe and tube making concern in this country that operates independently of the Pipe Trust (United States Steel Corporation), is using only wrought iron in the manufacture of its pipe and all well goods. For some grades of boiler tubes a certain trade demands the use of steel. This, however, is the only steel that enters into the manufacture of its products. It owns and operates its ore and coal mines, blast furnaces, puddle mills, rolling mills, foundries, forge, machine works, and pipe and galvanizing mills, and thus controls the various stages of manufacture from the ore to the finished pipe.

Notwithstanding the general opinion prevailing a few years since that steel was destined to supersede wrought iron in every branch of manufacture, the Reading Iron Co. has had sufficient confidence in the superiority of iron over steel in pipe and tubes to induce it within the past few years to very largely increase its capacity for making wrought iron by the building of new puddle mills and the purchase of several existing ones. Since the discussion in the technical press seems to have demonstrated the preference of many engineers for wrought iron, and since, as they say, it is practically impossible for the ordinary user to distinguish steel from iron by surface inspection, it will certainly be of interest to some of your readers to know that such pipe is manufactured and by a concern whose reputation is such that its guarantee of quality gives the purchaser the full assurance that he is receiving what he pays for.

We think that it is but just, since you have given the statement of the difficulty of procuring strictly wrought-iron pipe a place in your valuable paper, that the courtesy of the same publicity should be given this announcement of the existence of a manufacturer of such material. We would be glad, therefore, to have you publish in your correspondence columns such portions of this letter as you think would interest your readers.

Yours very truly,

George B. Harris, Treasurer Reading Iron Co.

Reading, Pa., Jan. 8, 1904.

(Those of our readers who have followed the discussion on the above subject will recall that one of the points made has been that standard merchant pipe generally runs considerably under its nominal weight. In this connection we notice with interest an advertising circular sent out by a Pittsburg dealer in pipe,* from which we quote as follows.—Ed.)

WROUGHT-IRON PIPE.

There may be a mighty little difference, if any, in the price of iron pipe wherever you get it, but there is a whole lot of difference many times in its weight, often as much as 10%, which cuts a big figure in the cost and quality of what you get.

We sell honest pipe—pipe that weighs sixteen ounces to the pound—and you pay no more for it than for the short weight pipe.

The Conveyor System of the Edison Portland Cement Plant.

Sir: In the Engineering News of Dec. 24, 1903, and in the article describing the Edison Portland Cement Co.'s works at New Village, N. J., we find some statements, which, in justice to the Link-Belt Engineering Co. and the Dodge Coal Storage Co., of Philadelphia, and in fact to all of the well-known manufacturers of elevating and conveying machinery in this country, should not be permitted to go forth unchallenged. On page 559 is stated, "In the scraper conveyors, however, one novelty has been introduced in substituting sliding shoes in place of

*The Pittsburg Gage & Supply Co.

the usual wheels on the carrying chains." This is not a novelty in the sense intended, and is a well-known method of accomplishing this result, and has been in use by the Link-Belt companies for a great many years, and is still one of the regular methods of accomplishing this result. On page 561 is illustrated a swinging conveyor. This is not original with the Edison plant, but is, and has been exploited by the Dodge Coal Storage Co. for a number of years. The use of wire rope for conveyors is old in the art, and for such purposes as made use of at the Edison works has been abandoned. Putting flanges on the edge of a belt conveyor is also well known in the art and has been used for a great many years. It seems unnecessary at this writing to go into details elaborately, but in a general way the writer has no hesitation in saying that there are a dozen manufacturers of elevating and conveying machinery now operating in the United States, any one of whom could have made a simpler, cheaper, better and more durable installation than that at the Edison works; which excites the interest of those skilled in the art, simply as an illustration of how much expense can be gone to to accomplish certain results, in excess of what would have been expended had the problem been submitted to any one of the many competent concerns engaged in the business of elevating and conveying materials. In fact, such installations as that of the Edison Company are harmful to the elevating and conveying business in general. Yours truly,

The Link-Belt Engineering Co,
James M. Dodge, President.

Philadelphia, Pa., Jan. 5, 1904.

(In accordance with our usual practice we submitted a copy of the above letter to Mr. Edison, whose reply is given below.—Ed.)

Sir: I have noted the statements of Mr. James M. Dodge, regarding the conveyor system used at the plant of the Edison Portland Cement Co. Any engineer visiting a plant equipped with the Dodge machinery and comparing it with that criticised can easily see that his statements as to novelty, efficiency or cost per ton conveyed, are entirely erroneous. Yours very truly,

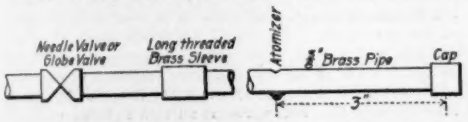
Thomas A. Edison.

Edison Laboratories, Orange, N. J., Jan. 14, 1904.

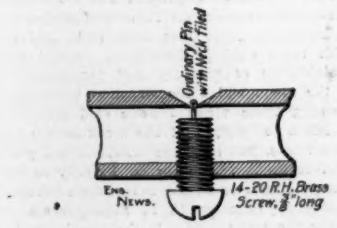
An Atomizer for Introducing Moisture in Furnace-Heated Houses.

Sir: The writer (referring to the recent editorial discussion and correspondence in the Engineering Literature Supplement on the need of moisture in furnace-heated houses.—Ed.) has been able to maintain a relative humidity of from 45 to 55%, with the outside temperature at and below zero, by the maintenance of a water spray, or atomizer, spraying into the hot-air chamber immediately above the firebox, where the greatest volume of air passes, spraying upwards and towards the firebox.

As you will note by the accompanying sketches, I get the



Elevation.



Atomizer, Enlarged.

Atomizer for Introducing Spray of Water Into the Hot Air Chamber of a House Furnace.

spraying effect of the ordinary adjustable nozzle for garden hose, using brass pipe where it is exposed to the heat, obtaining my orifice by drilling the pipe with an ordinary twist drill until same has very nearly perforated the pipe, and piercing through this with a fine needle.

It is evident that the device must be controlled by a valve, preferably a needle valve, according to the degree of moisture desired inside and the temperature and moisture outside; also that the device must be cleaned from time to time, which can be done by unscrewing the sleeve and removing the adjustable screw and pin.

The device is connected directly with the house water service. It has been used by me in different residences under water pressures ranging from 30 to 75 lbs. Variations in pressure are met by making the neck of the pin smaller or larger, as may be required.

I have used this method for 13 years. By this means a lower temperature in the house was necessary for an equivalent degree of comfort, and resulted in no irritation of the throat or damage to the furniture, etc.

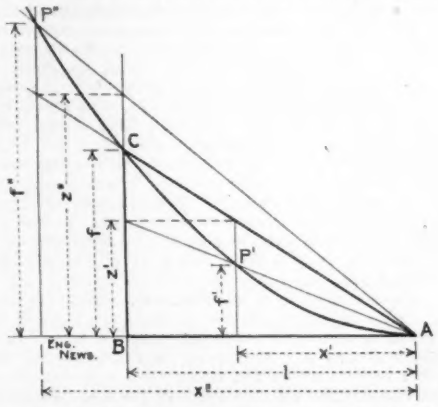
In the northwest, where the writer resided for many years, double windows are the rule, so that no trouble ensued from frosted windows, due to the moisture.

Very respectfully yours,
Wm. E. Saunders, E. M.

Philadelphia Gas Works, Philadelphia, Jan. 5, 1904.

A Simple Method of Constructing a Parabola.

Sir: Looking over Engineering News of Sept. 3, 1903, the writer noticed a letter under the above title, by Mr. H. Szlapka. The calculations, construction and "original proof" being such a long-winded affair, the



A Simple Method of Constructing a Parabola.

writer would suggest, for the benefit of your readers who may use Mr. Szlapka's method, one much shorter.

From the ratio of the ordinates in a parabola we have

$$\frac{l^2}{x^2} = \frac{f}{f'}; \text{ hence } f' = \frac{f x^2}{l^2}.$$

But from the method of construction shown in the accompanying sketch, we see that

$$f' = \frac{z\,x}{l}, \text{ and since } z = \frac{f\,x}{l}, \text{ this gives } f' = \frac{f\,x^2}{l^2}.$$

Hence, the point P is a point of the required parabola tangent to A B at A, and passing through the given point C.

This method gives any and all points of a parabola at any distance x from the apex A, which Mr. Szlapka's method fails to do. Herman G. Loeffler.

Craigsville, Va., Jan. 3, 1904.

Practice Regarding "Actual Area Cleared."

Sir: In reply to query, "What constitutes an acre of the actual area cleared," allow me to state: The contractor, generally before making a tender for clearing, grubbing and grading, has been over the line and his bid will be, and should be, based on his observation of the average density and size of the timber, and the confirmation and nature of the ground to be cleared. The contractor is then entitled to full acreage wherever he has cleared and grubbed, whether the timber stood one tree or a thousand and more trees to the acre.

The clause, "Actual area cleared," exempts from pay all territory upon which no clearing and grubbing whatsoever have been done, but for this clause the contractor would be entitled to acreage also on all treeless stretches, with the exception of water area, which it is the custom to always exclude. The above is the prevailing practice in a forest country. In sparsely wooded sections, where it is a question of cutting isolated trees, it would be best to let the contract of clearing and grubbing by stumpage, agreeing on varying prices according to the diameter of the removed trees or, a better solution, do it by day's labor. It is always well to reserve in the contract for the company or the employer, the ownership of all timber cut; to specify that large and valuable trees be cut as close to the ground as possible; these trees are to be trimmed and rolled off the roadway. The brush, refuse, etc., should then be gathered and heaped in piles remote from these logs and outside the limits of the grading; these piles should be burned at a seasonable time when danger from spreading forest and prairie fire is remote. In forest it is often advisable to cut outside the limits of the right of way such trees as are on the point of falling within its limits to the damage of fence and telegraph lines or are in danger of sliding (above sidehill cuts) on to the track. This work is done best by a small extra gang, working by the day under immediate orders from the engineer. The owners of timber so removed are of course entitled to a settlement, but as a rule they are content to take the felled trees.

Where the road owns valuable timber concessions adjoining the right of way and wherever such timber stands adjoining it, the engineer should have removed, for about 100 ft. each side of the track, all dry brush and dead wood which would be liable to take fire from locomotive sparks; the engineer should also prevail upon his employer to have fire-cuts made. These cuts should be with the direction of the prevailing wind. By these precautionary measures much valuable property is often saved and costly damage suits are avoided.

Of course this latter work is outside the requirements of the average contract, and, with the exception of the fire-cuts, can be performed by the section gangs as soon as trains start running. Yours truly,

G. W. Stadly, M. Can. Soc. C. E.

Sault Ste. Marie, Ont., Jan. 11, 1904.

The Grand Forks Water-Borne Typhoid Epidemic of 1893-4.

Sir: Referring to the articles in your issue of Jan. 7, regarding the epidemic of typhoid fever in Grand Forks, N. Dak., it may be of interest to call attention to the fact that a decided accumulation of sewage had taken place because of a stoppage of the main sewer. In fact "a large pond of sewage" had been formed near the railroad embankment.

When this "pond" was finally emptied into the river by the new outlet through the embankment the volume of pollution flowing into the river was very great; much larger than would result from flushing the sewer system of Crookston.

It may be added that although the onset of the disease was very sudden, its "intensity" was not high; in fact "the cases for the first few days of the epidemic were diagnosed as "la grippe." The mortality resulting was 7.71% of the cases. Such a figure for the mortality rate is commonly found in water-borne typhoid, when the infected water is from a stream. Polluted well waters usually give higher figures for the percentage of fatal cases. Yours truly, W. P. Mason.

Dept. of Chemistry, Rensselaer Polytechnic Institute,
Troy, N. Y., Jan. 8, 1904.

[This and other water-borne typhoid epidemics are discussed by Dr. Geo. A. Soper, in another letter published in this issue.—Ed.]

The Pennsylvania State Board of Health and the Butler Typhoid Epidemic.

Sir: In the excellent report by Dr. Soper on the outbreak of typhoid fever at Butler, which appeared in your issue of Dec. 24, 1903, and which I have read with much interest, I notice an error, which, as it reflects upon the State Board of Health of Pennsylvania, I will ask you to kindly correct in your next issue. It is as follows:

The State Board, through Dr. Wm. R. Batt, State Quarantine Officer, made an investigation, and, satisfied of the extent of the epidemic and of the probability of its continuance, established headquarters and assumed the responsibility of the sanitary measures which, in its view, the situation called for. Disinfectants, mostly of the patented variety, were ordered and distributed by the State Board in quantity.

It is the latter statement to which our board takes exception. The disinfectants which we have furnished have been undiluted carbolic acid of known strength; bichloride of mercury, principally put up in the form of tablets on our order, containing 7½ grains to each tablet; chloride of lime, quick lime and copperas. The only proprietary article which has been used was a small consignment of chloro-naphtholeum. The acid and bichloride were put up in small bottles for convenience of distribution, and this may possibly be the cause of the mistake made by Dr. Soper.

I enclose the labels used on these bottles, which will demonstrate our method of distribution, and which, I think, other boards may imitate with benefit in similar emergencies.

One other trifling error in the report I will also call to your attention: The original investigation was made by the State Board of Health itself in the person of three of its members, who inspected the water shed as far as the Thorn Run Dam, and satisfied themselves both of the nature of the outbreak and of its source. Dr. Batt, it is true, accompanied the board, but its conclusions were arrived at from personal observation.

I heartily endorse your editorial stricture on the whole state of Pennsylvania, which latter must be held largely responsible, both for the lack of vital statistics in one of its municipalities and for such inefficient sanitary measures as were exhibited at Butler by both the local government and the water company.

This is almost the identical language in which I have been appealing to the Pennsylvania legislature for nearly twenty years for the establishment of a proper system of registration of vital statistics at the capital of the state, founded on proper municipal registration, and for such legislation as will afford some protection to the streams of the state which, in the majority of instances, are the source of water supply. Yours very truly,

Benjamin Lee, Secretary, State Board of Health.
1420 Chestnut St., Philadelphia, Pa., Jan. 5, 1904.

[The first part of this letter has been referred to Dr. Soper and his reply is given in the latter part of a letter from him printed in this issue.

Four labels were enclosed by Dr. Lee. The one for carbolic acid is 3 x 3 ins., is printed in red, with the Pennsylvania coat of arms in blue. It

reads as follows, except that on the original display type and rules are used:

CARBOLIC ACID.
POISON.
Issued by the State Board of Health of Pennsylvania
For Purposes of Disinfection.

To disinfect Cesspools, Water-closets, or Urinals, add ¼ of the contents of this bottle to 1 gallon of water and use freely.

The other three labels are for corrosive sublimate. They are similar in style to the one shown above, and vary from each other in the final directions for use. The directions on one of them reads:

To make an antiseptic solution (1 to 2,000) for immersing Clothing, cleansing Floors or Furniture, dissolve 2 tablets in one gallon of water.

The other two corrosive sublimate labels appear to be for bottles of different sizes, one reading "dissolve 4 tablets in one gallon of water," and the other, "dissolve the contents of this bottle in five gallons of water."

The latter part of Dr. Lee's letter states well-known facts regarding the faithfulness with which he has contended for years against the indifference of the Pennsylvania public and the opposition of certain interests to much-needed sanitary reforms. We are glad to be able to publish so clear cut a statement of the case against the State of Pennsylvania.—Ed.]

Comparative Statistics of Some Great Typhoid Epidemics of Recent Times.—Disinfection at Butler, Pa.

Sir: At the conclusion of my report on the epidemic of typhoid fever at Butler, which appeared in Engineering News for Dec. 24, 1903, a brief table was given to show how the number of cases of fever at Butler compared with those recorded for some other epidemics of recent times. Through inadvertence, due in part to the necessity of completing the manuscript at the earliest possible moment, the epidemics of Caterham, Plymouth, Ithaca and Butler were given a more conspicuous and isolated position than they deserved. There have been epidemics of typhoid both more extensive and intensive than those mentioned.

In 1893, an epidemic of typhoid fever occurred at Worthing, England, and ran from May to November. Worthing, in 1891, had a population of 16,606. The number of cases recorded for this outbreak was 1,411, and the number of deaths 168. The epidemic was due to an infected water supply, obtained from wells put down into strata which were later found to be badly polluted by leaking sewers and broken drains.

In 1897, typhoid fever broke out at Maidstone, England, and ran from August until December. The population of Maidstone at that time was estimated at 33,830, and the number of cases reported was 1,928. There were about 150 deaths. The channel of infection was a water supply, furnished by a private company. The water was taken from springs, and the site of one of these, during a period of dry weather, had been used by a party of hop pickers for a camp. Typhoid fever existed in the camp, and it is believed that when the drought was broken the water of the spring carried the germs of typhoid to the city. The Maidstone epidemic should be particularly interesting to readers of Engineering News because it is said that some of the people who suffered from typhoid as a result of the infected water supply brought suit against the water company, and that their claim was finally settled for about $15,000.

An extensive epidemic, some of whose details have recently been brought to mind by Professor Gardner F. Williams (Eng. News, Jan. 7, 1904), occurred at Grand Forks, N. Dak., in 1893-94. Out of a population which has been given by Professor Williams as 4,979, but which, I think, might more properly be estimated at about 6,000, 1,245 cases and 96 deaths are reported to have occurred. In this instance, also, the cause of the epidemic was ascribed to the public water supply. The infectious agent is believed to have come from the town of Crookston, Minn., on the Red Lake River, some miles above Grand Forks.

An extensive epidemic occurred in the lower Tees River Valley, England, in 1890-91. It was divided into two distinct periods of six weeks each. The first outbreak occurred on Sept. 7 and lasted until Oct. 18, 1890; the second began on Dec. 28, 1890, and lasted until Feb. 7, 1891. In a population of 251,976, there was, in these two outbreaks, a total of upwards of 1,330 cases and 100 deaths. It was found that the communities which were attacked by fever obtained their water supplies from the Tees River, and that the banks of this stream were grossly polluted. Extensive floods, immediately antecedent to the outbreaks of fever, washed the filth into the river, and it is believed that the drinking of this water caused the epidemic.

A typhoid epidemic occurred in the Merrimac Valley of Massachusetts in 1890, under conditions which were somewhat similar to those of the Valley of the Tees. Several large communities, notably Lowell and Lawrence, suffered severely in this period, but the accurate number of cases and deaths and the dates of their occurrence are not readily available. Basing a calculation on the reports of the State Board of Health of Massachusetts, there were at Lowell, with a population of 77,696 by the U. S. Census of 1890, 858 cases and 65 deaths from April, 1889, to March, 1890, and 1,907 cases and 152 deaths from April, 1890, to March, 1891. At Lawrence, with a population, according to the census of 1890, of 44,654, there were 693 cases and 53 deaths from April, 1889, to March, 1890, and 1,099 cases and 84 deaths from April, 1890, to March, 1891. The totals for Lowell and Lawrence for the two years named are thus 4,647 cases and 354 deaths. Investigations by the State Board of Health showed that the epidemic at Lowell was due to an infected water supply, and that the sickness at Lawrence was largely attributable to drinking water containing sewage from Lowell.

But far more extensive than any epidemics yet mentioned have been those among soldiers confined in military camps. In United States camps, during the recent war with Spain, there were, among 107,973 officers and men in 92 regiments, according to the estimate of an official board of inquiry, 20,738 cases and about 1,570 deaths. These cases were distributed among several camps, but we may select one, the camp at Jacksonville, to illustrate the extent to which typhoid was prevalent in one locality. There were located at Jacksonville 16 regiments, of a mean strength of 18,749. Among these, it is estimated that there were 3,417 cases and 260 deaths. The fever was not attributed so much to water supply, as to transmission by what is popularly known as secondary infection.

In our Civil War, in the two years, 1862-3, there were reported, among 460,000 men in the Atlantic region, 29,666 cases and 7,092 deaths from typhoid fever. In the South African war, among less than 230,000 men, there were between 50,000 and 60,000 cases and 8,000 deaths. At Bloomfontein from the second of March to the middle of May, 1900, there were 4,667 cases and 891 deaths from typhoid among about 40,000 troops. In the Crimean war, for a period of seven months, between October, 1854, and April, 1855, out of an average of 28,939 men, there perished in hospitals or on hospital ships 10,053 men from sickness, a large proportion of which was undoubtedly typhoid.

To those who look for mathematical accuracy in the records of typhoid fever, there is much disappointment. There are many reasons why accurate statistics should not be expected. Physicians do not see every case of fever which exists; probably one-half of the typhoid cases that are visited by medical men are diagnosed as something else; in our best registration areas, a large proportion of known cases of typhoid go unreported; occasionally waves of typhoid fever pass over communities without being recognized as epidemics. The reports of epidemics which find their way into print seldom present the essential data in a way which makes them readily available for reference. In the memoranda which I have just given the number of cases and deaths which have occurred in the epidemics mentioned are as nearly correct as it has been feasible to make them. In most instances the information has been taken from official reports.

The epidemic at Grand Forks may be cited as an example of an epidemic which attracted very little notice outside of its immediate locality and for which the data are not as authoritatively established as could be desired. So far as I am aware no strictly official record of the number of cases and deaths attributable to this epidemic is obtainable. I have sought information from the State Board of Health of North Dakota, but have been informed that their evidence is merely hearsay. There is apparently no record of the epidemic in medical literature. The unofficial statement [see the comment following this letter.—Ed.] of a writer in Engineering News is all that we have of the facts. This information is valuable and the Engineering News is to be congratulated for printing it, if it is correct; but is it accurate enough to be used professionally, as, for example, in drawing deductions as to the distance through which an infected river may remain dangerous? I have found the account to be apparently inaccurate in an important particular which has immediate bearing upon this point. It is stated on page 342, Engineering News for May 23, 1895, that Crookston, the source of infection, was 60 miles above Grand Forks on the Red Lake River. I have referred to official maps published by the general government and have not been able to confirm this statement. The air line distance between the two places is not far from 25 miles, and the river does not appear to be particularly winding. The report of the State Board of Health of North Dakota, for the period covered by the epidemic, speaks of the distance as 26 miles. It is desirable that more light be thrown upon the Grand Forks case, and if any reader of the Engineering News has any first-hand information I hope he will let us have the benefit of it.

And while considering the question of corrections, it seems well to point out the error in the record given in Engineering News for January 7, 1904, for the cases which occurred within four or five months during the epidemic. Professor Williams has given figures for four months which correspond with yours for five. You have pointed out the discrepancy, but the matter is not entirely cleared up. Which is right?

Again, in commenting on Professor Williams' letter, you have made two minor mistakes which you may desire to have rectified. You have referred to an issue of your paper for May 22, instead of May 23, 1895, and in the next line you speak of the census of 1900 when you evidently mean that of 1890. [We stand corrected.—Ed.]

Dr. Benjamin Lee, Secretary of the Pennsylvania State Board of Health, has courteously called my attention to two errors in my report on the Butler epidemic. In my report I said that the Pennsylvania State Board of Health was distributing disinfectants, mostly of the patented variety, when I should have said, partly of the patented variety. Again, I plead guilty for having said that the state quarantine officer had inspected the drainage areas from which the infected water was derived, when I should have credited the whole board of health of Pennsylvania with this service.

I intended no reflection upon Dr. Lee or his board, with whose principle of action in assuming control of the sanitary situation I am in entire accord.* But I am not in agreement with certain features of the campaign of disinfection which was introduced by the state board, and since Dr. Lee has invited criticism on this point by proposing that other communities, in the event of epidemic, adopt the methods which have been introduced at Butler, I think it desirable to mention some of the reasons why other disinfectants and other mehods of distributing them may be more desirable.

A large part of the disinfectants for household use at Butler are put up in small bottles and boxes, such as are commonly kept at drug stores, and bear labels with directions for use. In most instances the disinfectant must be greatly diluted. In the form in which the disinfectant is distributed it is apt to be (1) highly poisonous, (2) corrosive, (3) expensive, (4) of unpleasant odor.

Of the various chemicals mentioned by Dr. Lee as being used at Butler, carbolic acid is relatively resistant to typhoid. Copperas is not, properly speaking, a disinfectant at all, but a deodorant. Crude lime is valuable chiefly as a desiccator. Chlorinated lime is so volatile that it soon becomes too weak to be effective. Chloro naphtholeum has been used chiefly, I believe, as an implement of war upon mosquitoes.

An objection to distributing so many different disinfectants is that those who must employ them are apt to become confused. Nor is this confusion likely to be relieved by the directions on the bottles. Who knows what is meant by such directions as the "Use freely" on the carbolic bottles?

It has long been a precept that partial disinfection is not possible; the germs must be entirely eliminated or there is no disinfection at all. The public has no knowledge of this. Scientific thoroughness in disinfection is a long way from the popular delusion that wherever there is an odor of carbolic acid or chlorinated lime there is safety.

Great epidemics give great opportunities for the education of the public in methods of sanitation. If typhoid fever is to be eliminated, or its increasing prevalence checked, we must introduce and teach the very best methods of disinfection which are available. The present tendency among scientific workers is to seek to destroy the infectious material as close to its source as possible. If we are to do this, there is need of simplifying our methods and making them more thorough and reliable. I do not hesitate to say that I believe the work of disinfection carried on at Butler by the State Board of Health of Pennsylvania does not represent all that is best and available under the circumstances. My view is that better results could have been accomplished had the disinfectants been (1) fewer in number, (2) less concentrated in form, (3) more inexpensive, (4) free from odor, and (5) furnished with more explicit directions. Would not milk of lime, bichloride of mercury and formaldehyde have served all the needs which the situation called for?

In expressing these views I have said nothing which should be taken to imply that the work of the board of health, as a whole, has not been excellent and productive of beneficial results. I also concur heartily in the view that Dr. Lee's efforts to obtain a satisfactory recognition of the needs of public health in Pennsylvania are deserving of the greatest praise. At the same time, I should not care to see other communities adopt the Butler methods of disinfection if simpler, cheaper and more effective measures were available—and I think they would be.

George A. Soper, Ph. D.
29 Broadway, New York, Jan. 16, 1904.

[We feel sure that many of our readers will be grateful to Dr. Soper for his summaries of the leading recorded water-borne typhoid epidemics. As to the official basis of the mortality records of the Grand Forks epidemic, it may be stated that the figures printed on p. 342 of our issue of May 23, 1895, were sent to us by Mr. W. S. Russell, who was then city engineer of Grand Forks, and, as we understand it, a member of the local board of health. The figures were given by months, and were specifically described as the record of the local board of health; or all the record that it had, since the board was not established until Jan. 1,

*See "The Management of Typhoid Fever Epidemics," a paper read before the Third Annual Conference of Health Officers of New York State, Albany, Oct. 9, 1903, and published in "Medical News" of Jan. 2, 1904.

1894, after the epidemic was well under way. The fact that Professor Williams mentions four months and that we mentioned five months as the period covered by the epidemic does not seem particularly significant, since the figures given by each agree in totals, and also for the worst month of the epidemic.

The approximate distance by river between Grand Forks and Crookston is an important question, since much may hinge upon whether the typhoid infection was transmitted 60 or 25 miles under ice. Mr. Russell, City Engineer of Grand Forks, stated the distance as 60 miles by river. The North Dakota State Board of Health, Dr. Soper says, gave it at 26 miles, about the time of the epidemic, which is virtually the same as Dr. Soper makes the air-line distance, as scaled from a map. The probabilities are that the state board also had in mind the air-line distance, as there certainly must be more than a mile of difference between the river and the air-line distance.—Ed.]

Notes and Queries.

C. R. C., Vancouver, B. C., asks whether concrete could be used for the lining of bee-hive coke ovens and whether it could endure the dousing with water when the coke is quenched, as well as the high heat.

F. V. M., Pittsburg, Pa., calls our attention to the fact that in the Engineers' Society of Western Pennsylvania there are not only a chemical section, but a mechanical engineering section and a structural engineering section. "All the sections," says he, "are as prosperous as the parent society, with an attendance at the average section meeting about half as large as that at a meeting of the whole society."

W. J. M., Fort Collins, Colo., writes:

Will you kindly give at your earliest convenience, through the columns of Engineering News, a fairly full statement of the best of the methods now known for rendering wood and cotton cloth as nearly fireproof as possible, or at least non-inflammable and slow-burning? Do such processes weaken the power of the wood to withstand the various kinds of loading?

The principal chemicals used in the so-called fireproofing wood processes are salts of ammonia and of aluminum. Common alum has a considerable effect to reduce inflammability. The details are kept secret by the manufacturers, but a search of the patents in the class will give the general methods followed. Fireproofed wood is generally more brittle than untreated wood; but the exact degree to which it may be affected in this and other ways depends on the details of the treatment.

AN AIR VALVE FOR REGULATING THE TIME OF PASSING THROUGH AN AIR LOCK; USED IN THE KIEL DRY-DOCK CONSTRUCTION.

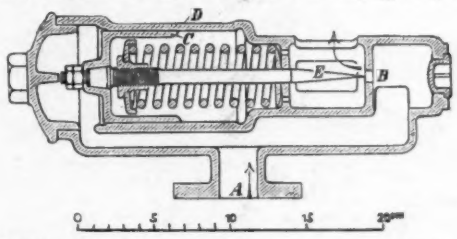
In describing the construction of the concrete dry-docks at Kiel, Germany (in our issue of Dec. 3, 1903), we mentioned that the air locks were fitted with valves designed to give gradual equalization of pressure between the two sides. The valves constituted automatic regulators operating thus: When locking-in, compressed air was admitted at such a rate as to give a uniform rate of pressure-increase (1.5 lbs. per minute), while when locking-out, the escape of air was regulated so as to give a uniform rate of decrease of pressure (¾-lb. per minute), only half as large as the rate of locking-in. The object of using these valves was to prevent the possibility of injury to workmen from too rapid transition to or from compressed air.

We show herewith a sectional drawing to illustrate the construction of the valves, in response to a request for further information concerning their nature and working. This should prove the more interesting because in the extended use which American engineers have made of the pneumatic method of construction, no attempt has been made to reduce the injurious effects of rapid locking by employing valves with a controlled time-element.

The valve shown has a small air passage B, regulated by the needle E. This needle is attached to a small piston C, acted on by the higher pressure on one side and by the lower pressure on the other. This latter pressure is aided by a coil spring, which tends to force the piston to the left, opening the needle aperture to its full extent. The actual position of the needle at any time, therefore, depends upon the difference of pressure of the air on the two sides of the piston.

One such valve is attached to each air lock for locking-in, and another for locking-out. In the former, the compressed air from the supply mains enters at A, and passes through aperture B to the discharge openings at E, leading into the air lock. The air from A also passes around behind the valve piston and presses the needle over to the right up to a point where it is balanced by the pressure from the coil spring added to the pressure from the air in the air lock. As the pressure in the air lock gradually increases, the piston is forced over to the left, increasing the size of aperture B; since the effective head of air across B is now less, however, the rate of flow is not increased proportionately.

The valve for locking-out is connected to the air lock by the opening A, and to the external air by the openings at E. The operation is as described above. A separate smaller valve, however, admits fresh compressed air to the lock at half the rate of the escaping air, so that the effective rate of pressure-decrease is only ¾-lb. per



Section of Air Valve for Slow Pressure-Equalization in Air Locks.

Built by Koerting Bros. for Use in the Dry-Dock Construction at Kiel, Germany.

minute. It is well recognized, of course, that locking-out is more injurious than locking-in; a slower transition in locking-out was thought advisable for this reason. This might have been done by simply using a smaller valve, but the arrangement described was adopted at Kiel in order to supply fresh air to the caisson during the relatively long period of locking.

With a caisson pressure of 30 lbs. per sq. in., or two atmospheres, the operation of locking-in with the use of the above-described valves would require 20 minutes, and locking-out would take 40 minutes. These rates are of course exceedingly slow compared with American practice, but of course the principle can be worked out in a valve giving a more rapid equalization.

The valves were made by the firm of Körting Bros. Co., of Hanover, Germany. Regarding their operation the engineer in charge of the Kiel dry-dock construction say: "In general they gave very good satisfaction. Occasionally, however, they failed in cold weather through ice forming in them because of the drop in temperature produced by the expansion of air at the needle aperture. Difficulty was sometimes encountered in beginning the process of locking, when the valve could not admit air rapidly enough to close the lock doors airtight. Ordinary air cocks, which were also fitted to each lock, were used in such cases to give a sudden pressure-increase sufficient to seal the doors, after which the time-valve completed the equalization." The ordinary cocks, it should be remarked, were arranged to be operated only by special keys in the possession of inspectors and lock-tenders.

EXPERTS' REPORT ON THE CONDITION OF CHICAGO THEATERS.

Immediately after the fire in the Iroquois Theater, Chicago, on Dec. 30, the Chicago "Tribune" organized a special commission of competent technical men to investigate the conditions at other Chicago theaters in regard to safety of construction and equipment. This commission was composed of the following members: Engineers—Louis E. Ritter (Ritter & Mott), Lightner Henderson (Purdy & Henderson), E. C. Shankland (E. C. & R. M. Shankland), and Frederic Sargent (Sargent & Lundy). Architects—W. L. B. Jenny (Jenny & Mundie), Charles S. Frost (Frost & Granger), James Gamble Rogers and William Holabird (Holabird & Roche). Building contractors—John M. Ewen (Thompson, Starrett Co.), Addison E. Wells (Wells Bros. Co.), William Grace (William Grace Co.), and Paul F. P. Muller. Fire insurance specialists—F. J. T. Stewart (Superintendent of Inspections, Chicago Underwriters' Association), I. J. Lewis, and Fred. S. James. This commission inspected 34 theaters, and on Jan. 11 it presented the following report:

Your committee has visited the following theaters (list omitted.—Ed.) and finds that none of them fully complies with the existing city ordinances. The more important violations found lead us to recommend the following items for consideration:

(1) An automatic sprinkler system should be installed in all cases, to be approved by the commissioner of buildings, fire marshal, and the board of underwriters of Chicago.

(2) In addition to the sprinkler system, a practical water curtain be installed, adjacent to the proscenium arch, said water to be controlled by hand valves from either side of the stage.

(3) A stand-pipe shall be installed on each side of the stage, with a hose connection at each level above and below the stage, these stand-pipes connecting with a tank on the roof, and in turn with a fire power pump, all subject to the approval of the fire marshal.

(4) In all parts of a theater, such as dressing rooms and so forth, a generous supply of fire extinguishers should be installed.

(5) There should be from two to four actual firemen from the pay-rolls of the fire department, and under the control of the chief. All employees of the house should be under the control of the firemen, in so far as it relates to the safety of the public, and should remain on duty until the house is empty.

There should be a daily fire drill and a daily report made as to the efficiency of the force and apparatus, to the chief of the fire department.

(6) All exits should be left unlocked and should open easily in such a way as to not block passages to fire escapes. There should be an increase of exits and positive assurance of doors being opened by employees stationed at their posts. This is strongly urged.

(7) All aisles should be spacious and lead without turn to exits, and should be free from all incumbrances, either temporary or permanent. There should be an aisle at each end of row of seats, and the rows should be limited in length.

(8) The main exits for all galleries and balconies should lead directly to the streets and alleys.

(9) The ordinance regarding smoke flues over the stage should be strictly enforced, and the dampers should be operated by a mechanical device worked from each side of the stage.

(10) The ordinance regarding facing on three public spaces should be enforced both in spirit and intent, and there should be to these open spaces, exits from each floor of the theater, with separate stairs having access to the street or open spaces.

(11) The ordinance regarding levels of auditorium floor should be enforced.

(12) All stairs should lead directly outdoors and not discharge into any other line of exits.

(13) The ordinance regarding the control of lights should be strictly enforced, and further, an independent system of lights should be installed for exits, both inside and out, and also for lighting the house.

(14) All exits, stairways, and outlets should be distinctly marked and also distinctly lighted during the performance by independent safety lamps.

(15) We do not think that the present ordinance provides for a curtain adequate for the purpose intended. As to how this curtain or movable fireproof partition should be constructed your committee is not prepared to state at this time.

(16) The ordinance regarding fire alarm boxes should be strictly enforced.

(17) The ordinance against overcrowding or standing in a theater should be strictly enforced.

(18) All scenery and stage paraphernalia should be rendered non-inflammable. We consider this one of the most vital points.

As we have called attention to certain points that have been brought to our notice after seeing so many flagrant violations of the building ordinances, we would urge the necessity of enforcing the ordinances, which, however, should be modified to meet the present requirements of the times, and in many cases should be made more stringent.

We submit the above preliminary statement, but await the copies of the fire ordinances that you have sent for from Boston, New York, London, Paris, Berlin, Vienna, and St. Petersburg before completing our report.

We have detailed data on each theater inspected, which we will submit in the near future, comprehensively showing the plans of the buildings, aisles, exits and general arrangements; also a comparative statement setting forth compliance or non-compliance with the ordinances in each case.

Another report was made by a commission appointed by Mayor Harrison to make an examination of the Iroquois Theater, and of the causes of the disaster. This commission consisted of about

30 members, representing the Builders' Club, the Builders' Exchange, the Masons & Builders' Association, the Chicago Architects' Business Association, and the Illinois Chapter of the American Institute of Architects. A published summary of this report is as follows:

The primary cause of the Iroquois theater building fire was sparks or heat from an electric projector, spot or flood light, igniting draperies back of proscenium arch about 12 ft. above stage floor.

The fire extended because there were no adequate means at hand to extinguish same. The "Kilfyre" provided proved ineffective. There were no vertical stand-pipes containing water under pressure, provided and connected with hose, on hose racks at convenient locations on flies and bridges. No automatic sprinklers. There were no fire hooks, which could have been used to tear down the burning portion of the scenery.

The fire spread to the auditorium because the fire curtain did not operate effectively. The descent was probably interfered with by some projection, by delay in attempting to operate same until fire had obtained some headway, by insufficient provision for effectively operating same, and by air pressure producing friction against brick wall.

Numerous exit doors were locked or bolted with devices not familiar to the general public. All exits were not manned.

The independent gallery stairs required by law were closed against exit by a locked door at foot of top flight. The arrangement of these stairs was of faulty construction as to width, pitch, turns and railings. The outer iron alley shutter, not being opened and swung back against the wall before the performance, when opened later during the panic, prevented people from continuing down the fire escape, on account of the cross-bars of the door being caught on the railing of the fire escape, thus effectually blocking the passage.

It should be noted that, in the majority of cases, stairways of ample width were provided, but these were, to excited people whose natural inclination would be to leave the house by the same exit used in entering, confusing in arrangement. It should also be noted that ample exit provisions were made and that the doors in same were bolted with bolts which could be operated from the auditorium side by any one, without the use of key, but that the public did not understand their use and the ushers had not been drilled or instructed and neglected to open a number of same.

The causes of death were two: (1) Asphyxiation from the first blast of smoke, gas and flame from stage; (2) burning, on account of exits being blockaded as the result of people falling, and on account of the fire escapes from the upper gallery exits passing lower exits out of which flames were bursting.

THE ROUTE OF THE THOUSAND-TON BARGE CANAL

We reproduce herewith a map just issued by the State Engineer of New York showing the route of the proposed 1,000-ton barge canal from Lake Erie to the Hudson, with its branches to Lake Champlain at Whitehall and Lake Ontario at Oswego. A separate symbol indicates where the location is changed from that of the existing canals.

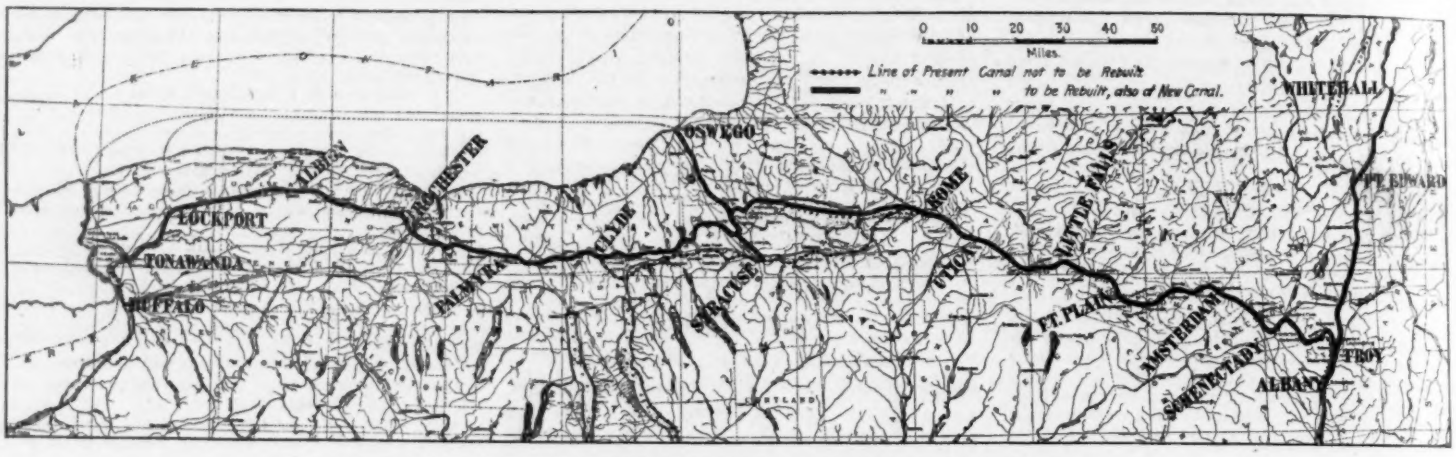
It will be seen from the map that the most important change in location is in the central part of the state, from Rome westward, where the barge canal is to go to the northward through Oneida Lake. Syracuse will be reached by a branch and will not be on the main line of the canal as at present. Another important change, which, however, it was not possible to show on the map, is the use of the Mohawk River by a system of slack water navigation instead of making the channel in excavation along the bank like the present Erie Canal.

On Jan. 12, examinations were held by the New York Civil Service Commission, and also by the United States Civil Service Commission, of applicants for engineering positions in the barge canal work.

The list of applicants who were notified by the Civil Service Commission to report for examination shows totals as follows:

Position applied for.	In N.Y. state.	In other states.	Total.
Assistant Civil Engineer.....	125	114	239
Leveler	117	98	215
Civil Engineer Draftsman.....	55	47	102
Bridge Designer	5	14	19
Bridge Draftsman	7	17	24
Junior Bridge Draftsman.....	59	15	74
Mech. Engr. and Draftsman....	16	11	27
Resident Engineer.	155	89	244
Total	539	405	944

Besides this there were 1,232 applicants for the position of chainman and 309 applicants for the place of rodman, making a grand total of 2,485.



MAP OF PRESENT AND PROPOSED CANAL SYSTEM OF NEW YORK.

(Reproduced from map accompanying annual report of State Engineer and Surveyor, Edward A. Bond.)

SOME OF THE CAUSES OF RECENT FAILURES OF REINFORCED CONCRETE.

By Julius Kahn,* Assoc. M. Am. Soc. C. E.

There have been so many failures in reinforced concrete buildings of late, that it becomes a matter of importance and self-protection for every engineer and architect designing this type of construction to reflect and study their cause. If this construction is all that has been claimed for it by men of prominence, if large and important works of engineering have been successfully and economically accomplished, then, indeed, reinforced concrete has come to stay, and the engineer must awaken to its study, that he may hold his position in the line of progress of the engineering world. If, on the other hand, this type of construction is unscientific and theoretically unsound, then, indeed, it is his duty to condemn it and exert himself towards its non-adoption.

The writer has given this subject considerable study and feels such perfect confidence in reinforced concrete that he cannot bear to sit by quietly and allow, what he considers a most beautiful field of construction, to be ruined by the incompetence of the men who so largely work therein. He feels it his duty, therefore, to place his views regarding some of the failures of reinforced concrete before the public, and he trusts that architects and engineers may agree with him, and possibly be more cautious in the design of works of this nature, and in entrusting them to men of competence and conscience.

The failures of concrete are generally due to one of the following causes: (1) Weak and insufficient centering. (2) Bad material and mixing. (3) Insufficient and improper reinforcement.

It is, of course, of primary importance that the centering for these structures should be sufficiently strong to carry the dead weight of the concrete while it is as yet green and unset. In a number of failures which have been described in engineering journals up to the present, the centering collapsed under the dead weight, allowing the heavy concrete to fall on the floors below, and to carry these with it. Such failures as these are, of course, entirely inexcusable. The writer does not feel it important to lay stress on this matter of centering; common sense alone should demonstrate the importance of making it sufficiently strong.

Regarding the materials used for reinforced concrete, it is of course essential that these be of the very best grades. Portland cement is manufactured in this country of such excellent quality and at such a low price, and tests are so readily made thereon with even the simplest appliances, that the use of poor cement is hardly excusable. As for clean, sharp sand, and broken stone or gravel, these are procurable almost everywhere. Regarding the mixing of concrete, there are on the market at the present time a number of makes of very excellent machine concrete mixers; and, where conscientious workmanship exists, no reason can be given for the poor handling of materials.

The writer sincerely believes that the majority of contractors who are working in this type of construction are conscientious, and that they make every attempt at good, honest workmanship. Unfortunately, however, only very few possess a scientific knowledge of the materials with which they are dealing, and their work at its best is mere speculation, which, if it stays in position after loads are applied, is considered successful, and if it falls down, is called a failure. Such a time for judgment is late indeed, and the lesson generally costs the reputation gained after a life of hard toil.

Bad materials and workmanship are the generally credited causes for the failure of concrete structures, but the writer is absolutely certain that in the majority of cases where our leading engineering journals have held out in this manner, the causes were of a different nature.

Let us consider for a moment some of the types of reinforcement used for long span floor systems at the present day. Among those most prominent are expanded metal, wire cloth, and plain or deformed rods.

Regarding the first two of these constructions, the writer has come into repeated contact with standard floors about as follows: Spans up to 22 ft.; thickness of floors, 5 and 6 ins.; material, cinder concrete; area of reinforcement per foot of linear cross-section of floor, 3-16-in. to ¼-in.; the floors being in the majority of cases a single slab. If a floor of 22-ft. span were constructed of 6-in. I-beams placed side by side as closely as their flanges would allow, and such a floor were subjected to the ordinary lightest live loading, to-

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gether with the plaster and wood floor, the same would deflect from ⅔ to ¾-in. Yet, these concerns who pretend leadership in reinforced concrete constructions, have built floors repeatedly of concrete, reinforced as above, using even cinders instead of stone, and producing concrete with only one-half the strength of stone concrete. Are failures of such constructions as these to be made the argument for the abolishment of reinforced concrete? Ir, on the other hand, such constructions as these do stand, as proves to be the case with but few exceptions, then indeed we may expect in scientifically constructed works of this nature wonderful possibilities; and, for the progressive engineer, a new field has opened, wherein he may design with greater economy than he has ever done heretofore, where his structures may have the permanency of masonry and yet the strength of steel, with the fireproof, rustproof and rotproof qualities of concrete, together with that wonderful property of all cement construction, its increasing strength with age.

The writer has seen floors reinforced with expanded metal as above described, deflecting as much as 3 ins., immediately on the removal of centering, after the concrete ahd been allowed to set for a month or more. How it could possibly do otherwise than deflect, was to him more of a problem than that it should fall down. In spans where the writer should deem it necessary to insert at least ¾ sq. in. of metal per running foot of floor, he has seen expanded metal floors stand up with less than ¼ sq. in. Who should be blamed for failures such as these? Is it a fault of concrete, is it poor mixing, or is it the ignorant boldness of a concern dealing in what it does not understand?

The writer knows of concrete floors 6 ins. thick and 22-ft. span, with nothing more embedded therein than a wire cloth, with occasional cables of similar wire, ½-in. in diameter, the total reinforcement providing a cross-sectional area of steel per running foot of floor of about ⅛ sq. in. As already said above, even common sense engineering should protest at a floor designed in this manner. If a floor were specified to be of such thickness and span, by all the rules in creation the writer could not calculate it strong enough with less than ¾ sq. in. of metal per running foot, and, although structures designed as above do stand, their factor of safety is probably 1½ at full loading at rare occasions it may be two, and sometimes a little less than one, in which case we have the natural collapse.

Our patrons of wire cloth will tell us of the high tensile strength of the wire, but only recently the writer had occasion to test a sample of the most largely used brand and found its strength to be only slightly above 60,000 lbs. per sq. in.

The failures which have occurred by the use of plain or deformed rods are also becoming quite common, and a little study of the method of fail-

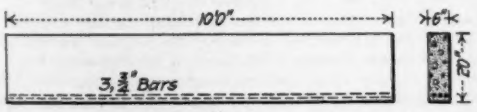


Fig. 1.

ure will at once bring forth the large faults in design. The generally adopted arrangement of reinforcement with rods has been to embed them along the lower edge of the concrete floor beam for the purpose of supplying the tensional strength in which concrete itself is so largely lacking. The principle of supplying steel in this locality is proper enough, and the generally adopted methods of engineers for determining the quantity of steel required at the center, possibly true enough providing the beam actually failed there at test to destruction. But the fact of the matter is, a beam reinforced in this manner and subjected to stress so that its shearing as well as bending strains are developed, rarely fails in this manner, and our calculations for the beam have therefore been made for the wrong place in the beam. Such a beam will invariably fail by the shearing of the concrete at the ends, diagonally from the point of application of the load, or longitudinally along the reinfocement bars. Take for example a given beam, as shown in Fig. 1, wherein the reinforcement is horizontal only. Assuming such a beam to be 6 ins. wide and 20 ins. deep, and to have three ¾-in. bars embedded along the bottom edge. Such a beam, if the full safe strength of the metal were developed, should have a carrying capacity of about 25,000 lbs. uniformly distributed, and if a factor of safety of four has been assumed, it should carry 100,000 lbs. before failure. Now, regarding for a moment this beam in shear, its cross-sectional area is 120 sq. ins., and assuming the safe shearing value of concrete to be 50 lbs. per sq. in., the beam would only carry a safe load of 6,000 lbs. in shear, instead of 25,000, as it should do when bending moment alone is considered. The writer has made a number of tests on concrete in shear, and has rarely obtained results larger than 250 to 300 lbs. per sq. in. It is evident that a beam thus reinforced is exceedingly weak in shear.

Vertical shear is, however, not alone to be considered. The matter of longitudinal shear along the steel reinforcement is of equal importance. In an ordinary steel girder it is generally agreed

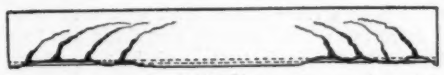


Fig. 2.

that the vertical shear is transmitted into the bottom horizontal chord within a distance equal to the depth of the girder. There is no reason to suppose that this principle does not apply with equal truth to reinforced concrete girders, and according to this the shear of 12,500 lbs. should be carried from the concrete into the steel within a distance equal to the depth of the girder; which means that the safe adhesion between three ¾-in. bars and the concrete within a length of 20 ins. should be 12,500 lbs. Ordinarily where a large body of concrete surrounds a bar, it is safe to count on an adhesive strain of about 50 lbs. per sq. in., which would produce a safe loading of about 12,000 lbs., but in this case the bottom of the concrete beam has been so cut up with steel that even if the required adhesion were there, the layer of concrete immediately surrounding the bars would not be capable of transmitting this strain. If the steel is to receive a stress of 12,500 lbs., the concrete must transmit the same into it within a length of 20 ins. It is ridiculous to assume that a layer of concrete 6 ins. wide cut up by three bars such as this, is capable of transmitting safely such stress.

The general method of failure above described is, therefore, a common one, and whether the rod be plain, twisted, corrugated or bulbed, adds very little to the strength of the concrete. It is the layer of concrete immediately surrounding the bar which is incapable of transmitting the longitudinal shearing stress, and which fails; the matter of adhesion is but a small factor in comparison with this. But, neglecting even this inability of the concrete to transmit such shearing strain, the writer has seen reinforced concrete beams constructed by some of the leading reinforced concrete concerns in this country where the bottom of the beam was so cut up with twisted and otherwise deformed rods, that a portion of it fell off without any load whatever being on the beam and leaving the rods entirely exposed thereby.

To take up the vertical shear it is generally recognized that some form of vertical reinforcement is necessary, and Hennebique, as well as other constructors in concrete, has supplied stirrups set up loosely about the rods. To the writer such stirrups seem unable to accomplish the necessary results. In the first place, shear cracks generally occur as shown in Fig. 2, being inclined to the vertical at an angle of about 45°. If vertical reinforcement is necessary at all it should cross these lines of rupture at right angles to hold together the concrete where the natural tendency is to open up. In the second place, if this vertical reinforcement is to carry strains at all, it should carry the same into the bottom chord member, and should therefore be rigidly connected with the same. These two principles seem to the writer just as important of observance as the placing of steel in the bottom. Hennebique supplies the stirrups, but, in the first place, he sets them in a wrong direction, and secondly, he makes absolutely no connection between them and the main steel bars.

To review the matter of vertical reinforcement, therefore, it seems to the writer that designs wherein vertical reinforcement is entirely omitted, are very dangerous, and where this reinforcement is in the form of vertical stirrups, they are decidedly faulty, although perhaps not equally dangerous. In the calculation of a steel structure, the engineer is very careful about the design and detail of every joint. Neglect to take into account a single connection may cause failure. Why then expect a reinforced concrete construction to take its full loading when only half way reinforced? It is true many accidents have occurred, but it is also true that the field of reinforced concrete is remarkably new and difficult; it requires great care and accuracy and should be handled by men of understanding only.

Would a construction engineer under ordinary circumstances submit the safety of his structures to the design of an ordinary layman unacquainted with the materials at hand? If he insists upon experience here, how much more so should experience and careful thought be insisted upon in the design of reinforced concrete, where the structure is of a composite nature, and everything about it is absolutely new. But the fact of the matter is that nine-tenths of the concerns now erecting buildings in this material neither employ an engineer nor have the slightest theoretical knowledge themselves in the calculation of the structures with which they are dealing.

Constructions in reinforced concrete designed by engineers have failed, but rarely because, as a rule, these men have used their technical knowledge and an inborn conservative caution in design. But where men have lacked such technical knowledge, they have invariably entrusted the work to concerns who specialize in concrete, and who have been paving or sidewalk contractors before. Such contractors are not so much to blame. They have faith in a material which, if well made, has wonderful properties indeed, and they are willing to risk their all for it. But any one who entrusts this construction with them is certainly guilty of gross negligence, for the problem requires fully the same scientific study as the steel skeleton frame, and demands the most skilful engineering knowledge. It seems pitiful, indeed, to see a contractor bear blame for the downfall of a structure such as was illustrated in Engineering News of Jan. 7, as having occurred a Corning, N. Y. The writer is acquainted with the contractor mentioned, and knows very well that this party makes no claims whatever at engineering knowledge. The concern which supplied this reinforcement and pretend to engineer contracts wherein it is used, had made fences its main business before, but suddenly discovering that steel embedded in the bottom of concrete loaned efficiency thereto, it plunged deeply into the field of reinforced concrete and hesitated at no constructions, no matter how difficult or how scientific.

Another matter wherein engineers are possibly at fault is the careless manner in which formulas are sent about by some parties with the assurance that structures will be safe if they are designed in accordance with them. On a recent occasion the writer visited the engineering office of one of the leading railway companies, where, in order to satisfy themselves regarding the uses of reinforced concrete for culverts, and the accuracy of the formulas advanced by some well-known concerns, a number of experiments had been made, using one of the generally accepted types of deformed rods. Beams were designed for safe loads of 20,000 lbs. It had been assumed in their calculation that the steel was to carry the entire tension of the beam, and naturally fail at test to ultimate destruction. The beams failed with loads in the neighborhood of 21,500 lbs., showing a factor of safety, therefore, of a little above one, instead of six or seven, as should be required for such structures. These beams were built with the usual horizontal reinforcement only; not even stirrups had been recommended. A single one of some twenty or more similar tests recently pub-

lished in one of our leading engineering journals, made at a well-known university, on 8 × 12-in. reinforced concrete beams, 11-ft. span, showed failure at 18,700 lbs. The safe strength, according to generally adopted formulas, if the steel had been strained to its complete tensile strength, should have been about 8,000 lbs., showing a factor of safety a little above two. In all of these cases the beams failed, shearing the concrete as usual long before the ultimate strength of the steel came into play.

The writer does not believe, however, that the failure of beams reinforced in the usual manner at a load less than the theoretically calculated load is as bad as the fact that the concrete has failed in preference to the steel reinforcement. He believes that a test structure should fail by the parting of the steel. Concrete, as well as all masonry, is granular and brittle, and fails invariably by a sudden collapse in shear. In order that a structure should carry a moving load, especially in railroad work, it should be an elastic structure capable of yielding under strain, and of large deflection before destruction. For this very reason an engineer does not allow a high carbon steel to be used in steel bridge construction subjected to rapidly shifting loads. If the concrete carries an undue proportion of strains, and if this is a brittle material, then indeed such a construction is dangerous, where subjected to sudden impact. It is like dropping an anvil on a cube of glass. If, on the other hand, the principal stresses are taken up by the steel, and if the concrete is subjected to compression alone, and if it is known that at ultimate destruction such a structure fails by drawing the steel in two at place of maximum bending moment, then indeed we have an elastic structure. Good mild steel will stretch as much as 20% of its length before failure, and a structure properly reinforced so that slipping of steel is impossible, and where shear, both vertical and longitudinal, are well provided for, should deflect as much as 12 ins. or more before failure, depending entirely on the span and depth of beam. Such a construction as this would be scientific indeed. It would possess the rigidity of concrete together with the elasticity of the steel. It would have resistance, and give ample warning before failure when overloaded. Such construction alone seems safe to the writer for use on building and railroad work, and any construction wherein concrete fails by shear most decidedly dangerous. Almost any structure that can be built of steel can be erected in reinforced concrete, at an economy of as much as 50% at times. All of the advantages of steel may be obtained without any of the disadvantages if concrete is properly reinforced; and combined with these advantages are the beautiful and remarkable properties of the permanency of good concrete.

What if a material may be subjected to rough treatment! Should this be a reason for discarding it? If in a structure costing twenty or thirty thousand dollars a saving has been made of from five to ten thousand, would this not be ample to pay for the employment of a good, careful inspector? Why do we insist on a mill inspector, a shop inspector, and a building inspector for steel work, and on the other hand allow sidewalk contractors to erect our most costly reinforced concrete structures? Does the blame lie with the contractor? No, by no means! Whoever turns responsible scientific work over to a man lacking knowledge of the materials with which he is dealing is just as much, and even more, to blame.

The writer feels himself somewhat at a disadvantage in discussing reinforced concrete, being a patentee of several methods of reinforcement; at the same time, self-protection as well as the interests of all engineers specializing in this class of work demands that some reason be given for the large number of failures repeatedly occurring. In the writer's early practice a large amount of concrete work was done for him by a number of concerns representing well-known systems. It was the wretched, unscientific work of these parties which compelled him for his own self-protection to study this new field, in order that he might prevent them from having catastrophies in his own buildings, for which they had previously submitted every sort of guarantee with bonds. Observing these wretched methods of reinforcement, and studying the failure of concrete beams, he decided upon certain methods being most theoretically perfect, and subsequently secured patents for same.

Although the writer lays great stress on the nature of the materials used, and its mixing, he believes that the matter of reinforcement is a dozen times more important, and he ventures to say that even the poorest mixture of concrete, if it were properly reinforced, would carry large loads before failure. Under safe loading the concrete should not be stressed more than 400 lbs. per sq. in. in compression, and a mixture must be very weak indeed which will not stand four or five times that weight. If the nature of the reinforcement be such that the concrete is subjected to compressive stress only, and the steel takes all tensile strains whatever their location may be, then failure seems almost impossible under safe loading.

In concrete structures erected by the writer, the centering has at times been removed with perfect safety at the end of three days. Surely the concrete had not set to sufficient hardness to carry heavy strains other than compression at that length of time. Tension and shear had been entirely provided for in these, and the writer knew very well that even at the end of three days the concrete had sufficient hardness to carry 300 or 400 lbs. per sq. in. in compression, and, therefore, the safe load.

Proper reinforcement is the first essential, good material and mixing are only secondary as compared with this. The writer has embedded his system of reinforcement in a beam of ice of 14-ft. span, and otherwise the usual dimensions of a concrete beam, and then imposed heavy loads thereon. Surely great shearing and compressive resistances were lacking here; surely even the poorest mud concrete should equal this construction, and yet the beam stood up like a rock under loading. Is this sufficient proof that proper reinforcement has something to do with the safety of reinforced concrete structures?

STEAM HEATING FROM A CENTRAL STATION.*

By F. B. Hofft.†

Central station heating is the result of several conditions: (1) The demand of the public, following (particularly in this state) failure of the natural gas, the uncertainty of the coal supply, and the complaint against the smoke nuisance; (2) probably the more important cause is the endeavor of the manager of the local electric light and power company to increase the earning power of his plant, and to get some revenue out of what might be called waste energy; namely, exhaust steam.

Central station heating may be divided into two classes: Hot water and steam. Steam heating may then be divided into (1) the straight heating plant (both high and low pressure); (2) the low pressure or exhaust steam plant. This latter class may again be divided: (A) the return, or where the condensation is returned to the power house, and (B) the one-pipe system, where the condensation, after being cooled, is discharged into the sewer and is a loss. This paper will be confined to the latter class, and more particularly to the plant of the Merchants' Heat & Light Co., of Indianapolis, together with its operation.

Simultaneously with the failure of natural gas, the uncertainty of the coal supply, together with smoke and the inconvenience of the individual plant, and a demand for cheaper electric light, a movement was set on foot by the Merchants' Association of Indianapolis, looking to the overcoming of these and many other difficulties, and the logical solution was central station heating. Mr. W. H. Schott, who later designed and installed the plant, was called in, and plans and estimates were furnished. A franchise covering the business section of the city for steam heating and electric light was secured July 29, 1902, and by the following January steam was being carried through a long system of mains and several buildings were being heated. Up to the present day, practically one year, the plant has given entire satisfaction, which is confirmed by the fact that about 125 of the largest business buildings, with a total of nearly 200,000 sq. ft. of steam radiation, are being supplied by exhaust steam.

The plant was designed to run condensing or straight electric during summer months, and with a back pressure of from 1 to 7 lbs. during the heating season. The capacity of the power house at present is but one-third of its ultimate size. It is equipped with seven 250-HP. Wickes water tube boilers, with Roney stokers designed for the burning of slack coal. There are three 500-HP. and one 350-HP. Ideal compound engines, designed to run condensing on 18 lbs. of steam per HP. per hour, and 25 lbs. of steam when running with a back pressure of 5 lbs. The engines are direct connected with three 350-KW. and one 250-KW. Western Electric direct-current 250-volt generators. There are also two 1,000-ampere compensators, one 2,000-HP. Cochrane-Sorge heater and purifier, and one 2,000-HP. Worthington jet condenser and cooling tower complete. A 20-in. Davis back-pressure valve is installed on the open air exhaust. There is also a 16-in. live steam line connected to the heating main through an automatic reducing valve to furnish live steam if there should be an insufficient exhaust to maintain the required heating line pressure.

The system of street mains were laid out to supply 500,000 sq. ft. of radiation with a power house pressure of 5 lbs., and at present there is installed 16,885 ft. of 8 to 20-in. mains. The greatest distance this exhaust steam is carried is 4,840 ft., and at this point there is a building requiring 7,500 sq. ft. of radiation. The most of the underground insulation was special design and built up of 2-in. hemlock lumber, set staggered, with two dead air cells between the layers of lumber, filled with a special hair felt. The space between the pipe and the insulation is filled with soft wood shavings, and the whole covered with a moisture-proof asbestos paper. The line loss due to radiation with this insulation is almost negligible. Expansion joints are placed about 150 ft. apart in manholes, the pipe resting on rollers, giving free travel. Services are taken off from up-turn tees and given considerable swing to allow slight travel of the main. Service connections are not made within 30 ft. of an expansion joint. Anchors are placed about midway between expansion joints, thus giving a maximum travel of any service connection of about 0.6-in. Line condensation is collected at the low points and discharged through traps into dry-wells.

Connection to the building is made to a suitable point in the consumer's system. A trap set on the return and condensation sent through what is called a cooling coil, which is water radiation set to heat the basement, or boxed up and used as indirect radiation on the first floor through a floor register. From the cooling coil or water radiation the water is discharged into the sewer at about 150°. In many instances this condensation is used to heat water for domestic purposes, by means of a range boiler.

Probably the most important feature of the entire system, from a satisfactory and economical operating standpoint, is the automatic temperature regulation for buildings. Its value as a steam saver can be placed at 40%, while its value, considering the even temperature, can hardly be estimated. Without temperature regulation, central station heating would not be the success it is to-day. Regulation on this system is obtained by means of thermostatic control of a regulating valve on the steam supply. This is operated by compressed air from the power house of 15 lbs. pressure. The valve is sneak feed and gives a regulation not varying over 2°. A small valved by-pass is connected around the regulator and the valve slightly cracked. This keeps the main warm during such time as the regulator is entirely closed for a considerable period, and prevents the regulator opening into a cold main, keeps the air out of the main and gives a more rapid circulation of steam.

Since it is exhaust steam that is used we will consider the heating as a by-product of the electric light plant. To do this we must charge up to lighting only that portion of the operating expenses required under the best operating conditions, i. e., running condensing, and charge against the heating the increase. To do this, we will have to assume average conditions and use the same conditions under each of the two cases. Get the operating costs of each, leaving out the factor that remain constant.

Assume an electric load of 750 KW. as average for 24 hours, and consider the plant first, as a straight electric light plant. As above mentioned, the engines are to run on 18 lbs. of steam per HP. hour. This will make a total of 432,000 lbs. of steam during the 24 hours. The running of the condenser pumps consumes say 40 HP. at 80 lbs. of steam per HP. hour, making a total of 67,200 lbs. The running of the cooling tower fan, say 20-HP. electric motor, would take in steam value about 21 lbs. per HP. hour, a total of 10,080 lbs. of steam. The boiler feed pumps will average about 15 HP. at 80 lbs. of steam per HP. hour, a total of 28,800 lbs. Thus we have an approximate value for steam consumption for 24 hours running as condensing plant, 538,080 lbs. of steam.

Now let us change the condition to heating. The average outside temperature for the city of Indianapolis for the seven heating months is 29°. With this outside temperature, and 200,000 sq. ft. of radiation connected, the power house pressure required will be 3½ lbs. This would mean a back pressure on the engines of 3½ lbs., and the steam consumption would increase from 18 lbs. to 26 lbs. per HP. hour. Going back to our electric load of 750 KW. under these conditions we will have an engine consumption for the 24 hours of 624,000 lbs. of steam. The boiler feed pumps will increase to say 20

*Abstract of a paper read before the Indiana Engineering Society at its annual meeting, at Indianapolis, Jan. 15.
†Merchants' Heat & Light Co., Indianapolis.

HP., a total of 33,600 lbs. The deep well pump will increase, due to the loss of condensation, about 5 HP. This is driven by electric motor, and placing its steam value at 21 lbs. per HP. hour, it will require 2,520 lbs. of steam. Adding this up we will get a total of 630,120 lbs. of steam. This will, together with its condensation, take care of 183,000 sq. ft. of radiation. Since we are figuring on 200,000 sq. ft., there will be live steam required for 17,000 sq. ft., or about 69,600 lbs. of live steam. We thus have a total steam consumption, when operating, heating and lighting, of 729,720 lbs. of steam.

There are other conditions entering, which must be balanced in heat units. For example, when operating under heating conditions, the boiler feed must be heated from the well temperature to 210°. The raising in temperature of 729,720 lbs. of water from say 50° to 210° will require about 117,155,200 heat units. To balance this feed-water heating charge, we will charge against the electric light plant, the heat units required to raise the water from a hot well temperature of 90° to 210°. This would be 538,080 lbs. of water, 120°, or 64,569,600 B. T. U., or difference to be charged against the heating department of 52,585,600 B. T. U. Reducing this to steam at 150 lbs. pressure (since no deduction was made from the steam available for heating), and charging it against the heating department, we have 40,000 lbs. of steam.

From the above figures we get, from the condition assumed, a total steam consumption, when running as a straight electric plant,, 538,080 lbs. of steam, and a total consumption of steam when running as both electric and heating, of 729,720, plus 40,000, equal to 769,720, or a difference in steam consumption of 271,640 lbs. of steam for the 24 hours. This amount, which is about one-third of the total steam consumption, together with the additional labor, represents the cost of operation, treating the heating as a by-product of the electric light plant.

THE MUNICIPAL TESTING LABORATORY OF INDIANAPOLIS.*

By Walter Buehler.†

The municipal testing laboratory of the city of Indianapolis came into existence in the fall of 1902. Prior to that time there was absolutely no systematic testing of any of the material used in construction of work done under the supervision of the city civil engineer. It is true that there were tests made of cement, asphalt and oils, but as no record was kept of such tests they are, of course, valueless at this time.

Mr. Jas. B. Nelson, knowing the value of a testing laboratory, determined to at least give it a start, and about $400 was expended in buying apparatus for the physical and chemical examination of cement. Later, after Mr. Nelson resigned and Mr. B. J. T. Jeup was appointed City Engineer, the laboratory was given a further impetus by the purchase of apparatus for the chemical examination of creosote oils, asphalt, and for the examination of the candle-power of artificial gas.

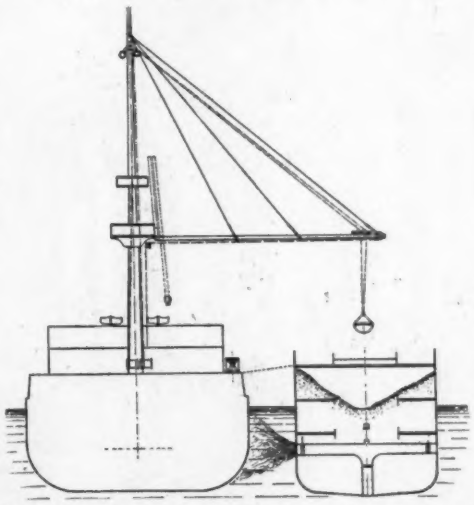
In making tests since the laboratory has been in existence, I have had in mind the importance of a systematic method of keeping the records of such tests, and, in the testing of cement, the value of uniformity of manipulation.

The specifications adopted by the Board of Public Works are taken as a basis for the acceptance or rejection of the cement. The samples of cement are taken from the work in strong paper bags, each bag having a number, which number corresponds to that on a tag which is filled out by the inspector collecting the sample. This tag with all necessary data pertaining to the sample, such as "Date when collected," "Where obtained" (meaning the exact location on any street), "The agent for the cement," "Contractor doing the work" and "The name of the man collecting the sample," is placed on file in the laboratory and afterwards copied with the results of the tests into a book printed expressly for that purpose.

The following tests were made of each sample: Fineness, tensile strength, initial and final set, soundness, specific gravity, and, when thought necessary, a chemical examination. In determining the fineness, 100 grams of cement are passed successively through a 100, 80 and 50-mesh sieve. The sieve is shaken by hand for 10 minutes, the screenings are then weighed and the sieve is shaken again for one minute and the second screenings weighed. If this weight is more than 0.1 gram the sieve is shaken again, and so on, till after shaking one minute, less than 0.1 gram passes through. The combined weight of the screenings is taken as the amount passing through that particular sieve.

The proper percentage of water required for the neat tests is ascertained by adding a small portion of water from a graduate till a stiff plastic paste is obtained, which will, when molded into a ball, withstand a fall of 20 ins. without cracking. Then 20 ounces of the cement are weighed out and placed upon the mixing table, into which the proper percentage of clean water is poured and the whole thoroughly kneaded to the proper consistency with the hands. It is then placed in the molds in three layers, each layer rammed 30 times with a brass rod ¾-in. diameter, weighing 1 lb. The briquettes are then numbered and covered with a damp cloth for 24 hours; at the end of that time they are removed from the molds and placed on edge in galvanized-iron pans, which are submerged in a large tank of constantly changing water. Briquettes are broken at regular periods of 24 hours, 7 days, 28 days and two months. The sand used in 3 to 1 and 2 to 1 tests is Ottawa sea sand passing a 20-mesh and being retained on the 30-mesh sieve.

For determining the time of set, the laboratory is provided with Gilmore needles. The 1-12-in. wire weighted to ¼-lb. is used for the initial set,



The Cunningham-Seaton System of Coaling War Vessels at Sea.

(Showing conveyor apparatus installed on war ships and water-jet device on collier. Dotted lines indicate coaling boom rigged in. Water-jet device installed to take water through bottom and discharge at either side.)

the 1-24-in. needle weighted to 1 lb. is used for the final set. In testing for soundness, the hot test, the air test, and the water test are used. In the hot test a pat ½-in. thick and 3 ins. diameter is exposed to steam for 6 hours and hot water for 18 hours. When practical, this hot-water test is made at the end of the 28-day test. The air test and water test are made on pats which are exposed to air and water for 28 days and studied at regular intervals. The specific gravity is determined by means of a Candelot specific gravity box.

All cements are from time to time subjected to a chemical analysis, for which purpose the laboratory has been equipped in every detail.

*Abstract of a paper read at the annual meeting of the Indiana Engineering Society at Indianapolis, Ind., Jan. 15.
†Assistant City Engineer, Indianapolis, Ind.

A NEW METHOD OF COALING WAR VESSELS AT SEA.

One of the most important problems of modern naval warfare is that of safely and expeditiously coaling vessels at sea from attending colliers. To make this possible a number of inventors have set their wits to work, and as a result several more or less practicable devices have been designed and tested. The most successful of these up to the present time is the cableway device invented by Mr. Spencer Miller, M. Am. Soc. C. E. This device has been installed on a number of war vessels, and was fully described in Engineering News of April 5, 1900. Recently another device has been suggested by Mr. A. C. Cunningham, Civil Engineer, U. S. N., and Mr. William Seaton, of the C. W. Hunt Co., of New York city. This device is described by Mr. Cunningham in the "Journal of the American Society of Naval Engineers," and from this publication we take the following account of its construction and operation:

The author has designed an apparatus for use in coaling ships at sea by means of which vessels may safely lie alongside each other for the purpose. The general principles of the apparatus are illustrated in the accompanying cut. In the illustration the jet apparatus is shown as a separate installation and fitted to the collier. The circulating and bilge pumps may, however, be used to produce the jet and the latter may be fitted to the warship instead of to the collier.

With the apparatus projected the ships are kept from touching each other and are maintained at the required distance apart by means of water jets which are the equivalent of elastic struts. The required distance between the vessels is secured by lines passed between the ships, for there are no rigid connections of any kind. It is not intended with this apparatus that any appreciable lateral speed should be produced; a tendency to separate the vessels sufficient to keep the connecting lines taut is all that is desired or necessary.

Neither is it necessary that the jet of water should reach from one ship to the other; the reaction of the jet upon the surrounding water is sufficient to produce the tendency to separate. The momentum of the water jets is imparted to the ships by reaction, and when a tendency to move or a slight motion has been produced the momentum of the ship for resisting wave action is very great. The resistance of the ship to which the connection is made to moving sideways through the water completes the combination. Theoretically, if time were of no consideration, very small jets would produce the necessary momentum. In emergency a collier may be temporarily fitted with the apparatus by installing centrifugal pumps on deck forward and aft and leading the suction and discharge pipes over the side when required for use.

Mr. William Seaton, M. E., of the C. W. Hunt Co., has proposed a coal-conveying apparatus for use with the water-jet device, which is also illustrated in Fig. 1. The lines having been passed between the ships and the water jets turned on and regulated, the boom is rigged out and coaling proceeded with. For the most rapid operation the coal is taken from the hold of the collier with a grab bucket, dumped into a hopper on the ship, and from thence conveyed to the coal chutes in cars.

The advantages of this apparatus are in being connected to one ship only and in having independent positive motion, thus permitting it to work without regard to the rolling or pitching of the ships, or of varying distances between them, as the vertical and lateral motion of the bucket are always under control. The bucket and hopper are not essential to the apparatus and the coal can as readily be conveyed in bags, only more slowly. When bags are used, the conveying apparatus can as well be on the collier as on the ship to be coaled, or a conveying apparatus can be rigged upon each mast of both the collier and warship.

By giving to the water-jet apparatus as much power as installed in an ordinary tug boat, valuable maneuvering properties may be secured which have not heretofore been possessed by ships, and thus make the water jets of value at all times. The tactical diameter would be reduced by such an installation. Direction of the vessel could be changed or maintained in action or on blockade without longitudinal motion. Docks could be approached and left with greater facility and safety, and a purely lateral motion could be obtained when desired.

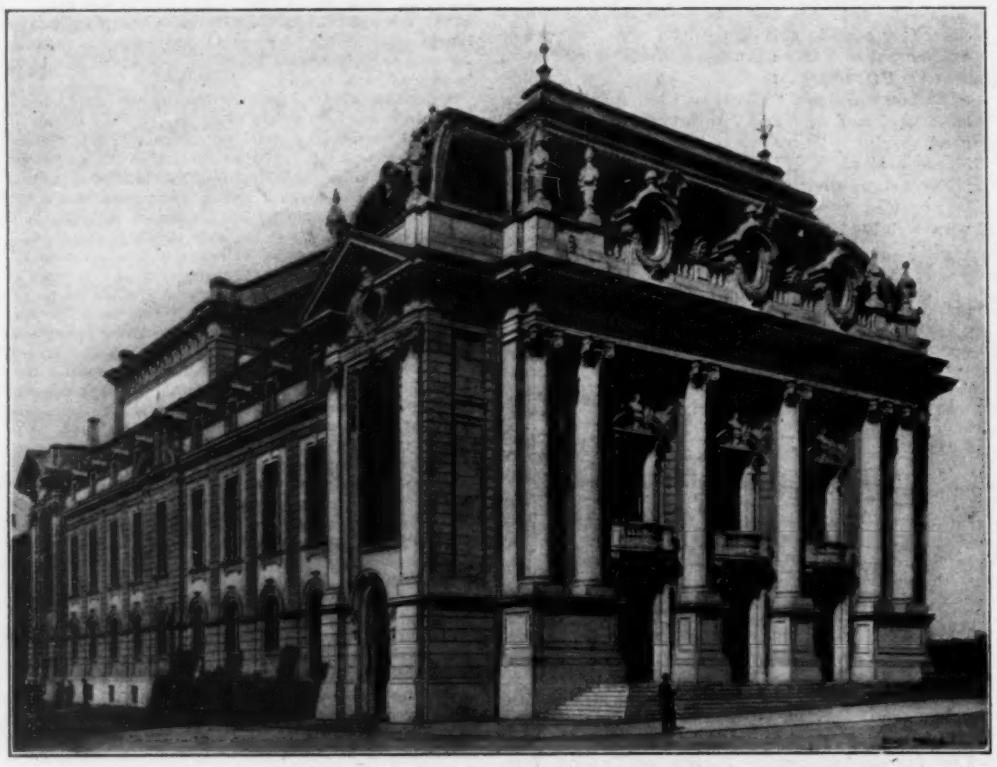
Although any one who purposes to place additional weight or occupy additional space in our already crowded warships may expect a cool reception, there are many considerations which indicate that such an installation as here projected should be made on the warships. It would then become possible to take coal from any kind of a collier without the latter having special fittings. Coal could also be taken from a captured vessel, or a warship could fasten her coal to another vessel of the fleet in case of emergency.

The simplicity and compactness of these proposed devices, the ease with which they can be installed on existing ships, and the general value of the water jets for maneuvering purposes, should commend the proposed method to naval authorities.

THE NEW STADT-THEATER AT BERNE, SWITZERLAND.

The interest which has been aroused by the Iroquois theater fire of Dec. 30, 1903, in the subject of theater construction, leads us to reproduce some floor plans of a new European theater of rather elaborate design. These plans reveal the interior arrangement of the theater in question—the "Stadt-theater" of Berne, Switzerland—sufficiently well to bring out some main features of difference from American practice, features which this theater possesses in common with many of the important theaters of continental Europe.

The large measure of consideration given to municipal art in Europe leads to the location of important public structures in commanding situations, as at the head of a public "square," where the monumental effect of the structure will have fullest value. Wherever practicable the arrangement is such that important structures stand by themselves detached from other buildings, gaining thereby in light and air, in accessibility, and in æsthetic effect. The Berne Stadttheater faces the "square" which constitutes the southern entrance to the well-known Kornhaus arch bridge (described in our issues of Dec. 19, 1895, and Dec. 16, 1897). Overlooking the deep valley of the Aare River, the building is thus excellently placed for monumental effect. This is furthered by its free position, almost wholly clear of neighboring



VIEW OF THE STADT-THEATER, BERNE, SWITZERLAND, FROM THE KORNHAUS-PLATZ.

buildings, and the architectural development of the building. The photographic view on this page gives a good idea of its appearance.

Although the building is larger than most theatres, being 98 ft. by 184 ft. in plan, the auditorium is rather small, and correspondingly more space is given to lobbies, passageways, and the stage, with its accessory rooms. This may be seen from the four plans of ground floor, first, second and third gallery, shown on the following page. The stage proper is 59 ft. square, the proscenium opening being 31 ft. wide. The stage is surrounded by a firewall the full height of the building; beyond this wall, at the sides and back of the stage, are arranged the various dressing rooms, trial rooms, offices, scenery storage spaces, etc., in tiers corresponding roughly to the levels of the galleries in the auditorium. This arrangement gives a maximum subdivision of the space back of the proscenium arch, which space, containing large quantities of inflammable material in the shape of scenery, etc., is almost the sole danger point in an otherwise fireproof theater building. The dressing rooms, also, are by this arrangement separated from the stage proper, instead of being located on galleries open to the stage, as is the usual practice.

The dressing rooms for solo artists are on the level of the stage floor, directly behind the stage; here also is the green room. Above these are the chorus dressing rooms, while on the third and fourth floors are offices and rooms for practice and rehearsals. At the sides of the stage are: on the first and second floors mainly storage for flies, with smaller spaces for stage lights, properties, fire department, and hair dresser on the first floor, and furniture and properties on the second floor; the third floor has a costume room on one side of the stage, and on the other side a dressmakers' room and a trial room; the fourth floor is for miscellaneous storage. There is an outside fire-escape on the back of the building, connecting with exits at all these floors. The regular exit on the first floor opens off the passageway running along the dressing rooms, whence also stairs lead up to the other floors. The scenery door is in the basement, so that there is no large opening in the firewall of the stage above the basement.

The auditorium, or rather that portion of the building lying in front of the proscenium arch, is characterized by a firewall completely surrounding the auditorium proper up to the level of the third balcony. The first and second balconies are very shallow; the third balcony, which is much deeper, extends back of the line of the firewall below and is enclosed simply by a thin partition wall. On all floors the space outside of the firewall or partition is used as a wide passageway leading to stairs and exits. The stairways are again separated from this passage by firewalls, except the stair from first to second balcony. A special feature is the provision of separate stairways for the third balcony, without communication to the other floors. These are at the extreme front of the building, one on each side (marked C in the plans).

Two features of the plans seem rather disadvantageous. The small seating capacity of the auditorium, only 940, is eked out by standing room spaces on the ground floor and the third balcony, calculated to accommodate 160 persons. Second, no exits other than those at the front of the building are provided, with the exception of a single small emergency exit, J, on the ground floor. The location of the theater clear of other buildings would have made it practicable to arrange several additional exits along the sides, so that the house could be cleared more rapidly in emergency. As will be seen from the plans, the natural location of these exits is occupied by the wardrobes.

It is worth noting as an unusual feature of construction that the interior of the auditorium is built of reinforced concrete. According to an article in the "Schweizerische Bauzeitung," from which we have taken our illustrations, reinforced concrete construction for the interior was adopted for considerations of fireproofing and in order to avoid obstructing the view of the stage by columns. The architect of the building is Mr. R. von Wurstemberger, of Berne, whose designs in the architectural competition for this building received first prize.

REPORT ON PROPOSED UNION ENGINEERING BUILDING OF BOARD OF DIRECTION OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS.

The attention of the members of the American Society of Civil Engineers is called to a decision of the question whether the society shall continue as heretofore to occupy its own building, or shall occupy, in common with three other national engineering societies, suitable space in a large building owned and controlled by a corporation composed of an equal number of representatives from each of these societies.

The manner in which this question has come to be considered by the American Society of Civil Engineers is this: On Feb. 14, 1903, Mr. Andrew Carnegie wrote this letter:

Gentlemen of the
American Society of Civil Engineers,
American Society of Mechanical Engineers,
American Institute of Mining Engineers,
American Institute of Electrical Engineers, and the
Engineers' Club.

It will give me great pleasure to give, say, one million dollars to erect a suitable Union Building for you all, as the same may be needed. With best wishes,

Truly yours,

(Signed) Andrew Carnegie.

Mr. Carnegie has since given verbal assurance that he desires to erect a building adequate in all respects to the needs of the societies with due provision for future growth, the cost not to be limited to the sum named in his original offer.

At the time the foregoing letter was written, the Engineers' Realty Co., an association formed for the purpose of providing a home for the Engineers' Club, had purchased a plot of land having 50 ft. frontage on 40th St. and a depth of 98 ft. 9 ins. half way between Fifth and Sixth Aves.

A plot of land directly in the rear of this property and fronting on 39th St., with a frontage of 125 ft. and a depth of 98 ft. 8 ins. has been purchased by Mr. Carnegie at a cost of $517,000. He proposes to sell this at cost and interest to the four engineering societies named in his letter, or such of them as will join in the purchase, after he shall have erected upon it a building (costing approximately one million dollars) to be made adequate to the needs of all the societies for a long time to come, which building will go with the land without extra charge to the purchasers of the land.

An adequate building will be erected by Mr. Carnegie on the adjoining lots which front on 40th St., and will be similarly conveyed to the Engineers' Club. It should be stated that the representatives of the several societies, including in this case those of the Engineers' Club, unanimously favor the complete physical separation of the two buildings. Mr. Carnegie has never formally acceded to this, but there is little room to question his acquiescence.

A conference committee of the four engineering societies has, after six months' deliberation, formulated conditions for the tenure of the property, the essential points of which are as follows:†

The title of the property shall be vested in an executive corporation, which is to be created by special act of the legislature, and is to be composed of twelve persons, three of whom are to be chosen by each of the aforesaid constituent societies.

The purchase money is to be obtained by the sale of bonds of the executive corporation, bearing interest at 4% per annum, and redeemable on six months' notice. Each of the constituent societies shall have the right to purchase at par, and hold inalienably, a proportion of these bonds corresponding to its interest in the executive corporation. It may hold a larger proportion, subject to one year's call of the executive corporation, at par.

To meet the expenses of interest, taxes (if any), and operation and maintenance, the executive corporation shall assess upon each of the constituent societies annually a sum sufficient to meet all obligations, proportioned to the space in the building occupied by such Society, as assigned to it by the board of directors of the executive corporation.

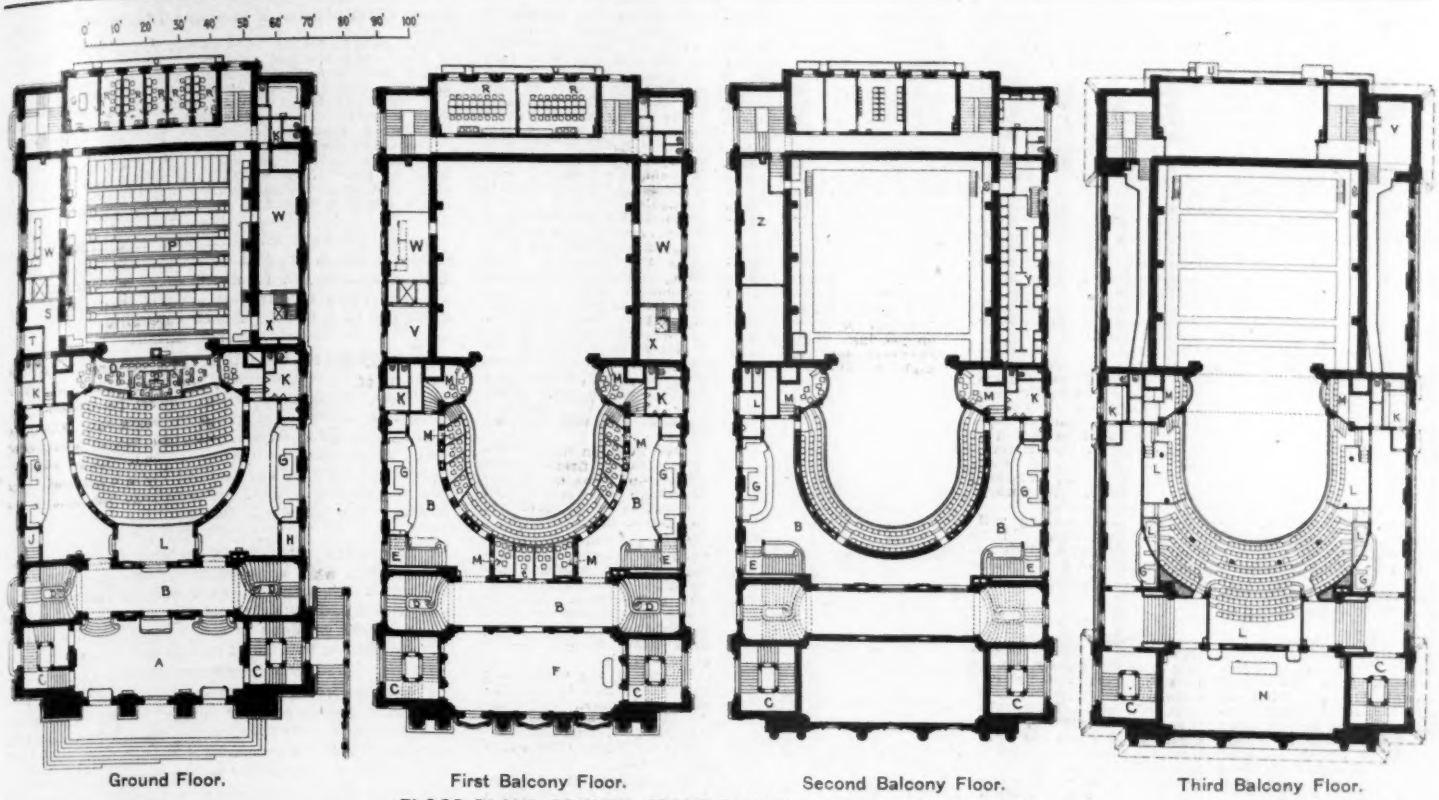
Other scientific associations may be assigned space in the building by the executive corporation, and the income derived from the occupants of the building shall be used by the executive corporation for defraying ordinary expenses, establishing a repair and rebuilding fund and the advancing of engineering arts and science.

The board of direction believes that this matter should now be presented to the membership for ballot, although the project is not as yet in shape for such presentation under the instructions of the Asheville convention. It has been demonstrated, however, that a building with suitable accommodations for all the constituent societies can be planned on the land selected and already secured.

The board believes that, in the interest of all the parties

*Report presented at the annual meeting of the Society held in New York City, Jan. 20-22, 1904.

†For text in full, see Progress Report of the Board on the Project, dated Nov. 18, 1903.



Ground Floor. First Balcony Floor. Second Balcony Floor. Third Balcony Floor.

FLOOR PLANS OF NEW STADT-THEATER, BERNE, SWITZERLAND.

A—Vestibule.
B—Promenade.
C—Stair to 3d Gallery.
D—Stair to 1st Gallery.
E—Stair to 2d Gallery.
F—Foyer of 1st Gallery.
G—Wardrobes.
H—Physician.
J—Emergency Exit.
K—Toilet-rooms.
L—Standing-room.
M—Boxes.
N—Bar-room.
O—Orchestra.
P—Stage.
Q—Green-room.
R—Dressing-rooms.
S—Stage-lights.
T—Fire Department.
U—Fire-escape.
V—Furniture storage.
W—Flies.
X—Properties.
Y—Costumes.
Z—Dressmaker.

concerned, a decision should be reached at as early a date as possible, and it is within the power of the annual meeting to order a letter-ballot, on the question as to whether the American Society of Civil Engineers shall become one of the constituent societies in the occupancy and control of the proposed union engineering building.

To cover this contingency, the board has prepared the following arguments for and against the project as at present formulated, for presentation to the annual meeting:

ARGUMENTS.

IN FAVOR.

1. The society now has an opportunity to become one of four equal participants in a gift of about one million dollars to be expended for a modern building adequate for the needs of all four societies for many years to come.

Such a liberal and generous gift has never been offered to the profession before, and such an opportunity to secure a suitable building for a great engineering center can hardly be expected to recur.

By the sale of our present property, which need not be hastened, a sufficient amount can be realized to cover the interest of the society in the land upon which the new building is to be placed, and leave a remainder for broadening the work of the society.

2. It is desirable to secure co-operation between the different engineering societies and the different classes of engineers. Engineers in different lines of work are not brought together as much as men in other professions, and the facility for meeting friends and widening acquaintance by being housed in a common building would be of especial value to them.

Better opportunities for individual intercourse and facilities for more frequent exchange of ideas and experience must be of benefit to the profession.

The present stage of civilization has been marked by a great development in the applications of science, and its advance has been largely the unrecognized work of the engineering profession. Future progress will perhaps be even more marked, and the profession of engineering should take its place as one of the most important agents in the advancement of civilization and the development of the country. It is urged that this project will aid in accomplishing this end.

Joint occupancy and contiguity of the several organizations in a commodious Engineering Building, centrally located, would tend to the unity and strength of the engineering profession as a whole. The present tendency is toward specialization, and hence a segregation, which is to be deplored, and which a closer association would do much to counteract.

3. Our present building, while adequate for ordinary meetings of the society, is inadequate in some respects for the requirements of the annual meeting—the principal occasion when non-resident members visit the society house. There is no proper accommodation for giving a luncheon on this occasion, unless the business meeting is held elsewhere; and, with the rapid increase in membership, these conditions will grow worse from year to year.

The new building will give much more space and better accommodations both in the business offices and the auditoriums; and ample space for a very largely increased membership in all the organizations. A large auditorium, with seating capacity for one thousand persons, and two or three smaller ones, with seating capacity for 200 to 400 each, will provide for all meetings. Suitable provision can be made for the convenient service of luncheon on any occasion.

The advantage to be gained by the common use of auditoriums, reading rooms, etc., could probably be obtained at less cost of maintenance and operation, than where different establishments are maintained; and the expenses may be partially defrayed by renting office space and auditoriums to other scientific organizations without interference with the work of the constituent societies.

This feature may be of considerable importance until by increase of membership the space becomes necessary for the use of the constituent societies, and when this occurs the societies will be so strong that the burden will be insignificant.

4. The collection of the libraries of floors of a large building by different societies of engineers, each desirous of preserving its individuality and increasing its membership.

The prestige of the profession of civil engineering cannot be enhanced by the collection in one building of a number of separate organizations with different requirements for membership.

It cannot be regarded as unquestionable that a greater intimacy between the several societies would be mutually beneficial by developing a deeper professional spirit.

The experience of the Institution of Civil Engineers of Great Britain indicates that a certain amount of exclusiveness and conservatism engenders in the members pride in the organization and solicitude for its welfare, and begets in the public a reliance upon its character, which might be jeopardized by such an association with other organizations having different histories, aims and traditions.

If, as may well be feared, joint occupancy of a common building should give rise to dissensions, the result would be a loss of prestige instead of a gain.

3. The present house of the society is a four-story and basement building of fine architectural appearance, planned and built expressly for it, on a 100-foot street, adjacent to two churches, and opposite to an imposing fine arts gallery. It is fully adequate to all the present needs of the society excepting only on the occasion of the annual meeting. The business offices, library and reading room, will be ample for a considerably increased membership.

When more space is required two or three more stories can be added, or adjacent property can be acquired, when this becomes necessary. The present property is nearly paid for, and the regular annual surplus of receipts over expenditures is steadily increasing; there can be no doubt that the society can make these enlargements or acquisitions whenever needed.

The experience had in the management of high buildings in New York and elsewhere, is to the effect that the cost of operation, per square foot of floor space occupied, is very much greater in a ten-story building with elevators than in a four- or six-story building without elevator service.

It is the opinion of experts in the management of buildings that the expense to this society, by becoming a participant in the management of the proposed building, would be very greatly in excess of its present expenditure for operation of its own building.

It is doubted that a building for a home for the several societies, ten stories or thereabout in height, giving adequate architectural effect for suitably impressing the general public, and creating a pride of ownership in the minds of the members of the several societies, can be built on the proposed site, on a narrow street, in the middle of a nine hundred-foot block, likely to be occupied by business buildings of greater height.

At some future date, even with the proposed liberal allowance, the space in the proposed building will become inadequate for one or more of the constituent societies; all will certainly grow, but the probability is that some will grow at the expense of the others. In this case the proposed engineering center will be broken up, as there will be no room for further expansion, and there is sure to be diversity of opinion as to which shall go and which shall stay. This emphasizes the objection to joining in a project which makes no provision for growth, or readjustment, beyond a certain limit.

4. With the libraries of

braries of the various societies in one building would facilitate greatly making researches, and would result in economy of time and efficiency. Each society would retain control of its own books, stored in separate stacks.

Each society could maintain and increase its library with no less freedom than if it occupied a separate building.

A common reading room would serve for all.

5. The new building, centrally placed between the two great railway terminals, and near the hotel district, will be more convenient to non-resident members, particularly to those leaving on late trains.

The proposed building will be about 2,000 ft. from the nearest subway station; 2,100 ft. from the Grand Central Station; 3,100 ft. from the new Pennsylvania R. R. Tunnel Station (now under way), that is to say, within 10 or 12 minutes' walk from either of these stations. The Sixth Ave. Elevated station is 1,270 ft., and the nearest East Side elevated station is 2,320 ft. distant. The Sixth Ave. surface car line is 500 ft. away, the Seventh Ave. car line is 1,400 ft. away; by which cars the ride to the Pennsylvania R.R. station would be 2 minutes; the 42d St. Crosstown line is 1,270 ft. away, and the Broadway surface car line 1,000 ft. away.

6. Associations of engineers should be mutually helpful. If this society does not join in this project, the burden upon the others will be greater. We are all members of one great profession. We should join hands with our brethren who are engaged in other lines; with the sincere desire that all work together to enhance the strength and influence of the engineering profession as a great unity.

7. The building would be under the exclusive control of the representatives of the four National engineering societies; these representatives forming an executive corporation in which each society would have an equal voice.

Such a corporation, made up of the best men in the constituent societies, could be depended upon to deal justly with all.

We should enter upon the project with a firm determination to avoid dissensions and to make it successful and helpful.

Possible difficulties should not deter us from joining in an enterprise which, with proper management may be made a great benefit to the profession.

The danger that any one of the four great national engineering societies may become unable to pay its

the constituent societies under the same roof, there will not be the same incentive for maintaining the completeness of each, as the feeling will be that the other libraries, readily accessible, can be relied upon to contain all books, relating to their specialties, and it might seem a waste of money and space to have in each of the four libraries a copy of the same book; yet it seems desirable to keep the library of this society, which is a general technical collection, larger and more complete than any other similar library in America, as complete at all times as if the society occupied independent quarters.

In case of withdrawal at some future time, the library should be as complete as if there had never been any association. It is probable that donations of publications would be restricted to one copy for the building, the several libraries being considered as one, and thus the growth of our library would be restricted.

5. The new building will be on a 60-ft. street in a district changing from a residential to a business character.

The present building is located in a 100-ft. street in a growing locality. It is 1,000-ft. from the nearest subway station, which is 5 minutes' ride from the Grand Central Station, or by walking 250 ft. to the Boulevard surface cars with 8 minutes' ride to the Grand Central Station, or by walking 300 ft. to the Seventh Ave. surface cars with 8 minutes' ride to the Pennsylvania R. R. tunnel station. There are five surface lines within a quarter of a mile: Broadway, 200 ft.; Eighth Ave., 550 ft.; Seventh Ave., 300 ft.; Sixth Ave., 1,200 ft., and 59th St. Crosstown, 800 ft. Two elevated railroad stations are each 1,600 ft. distant.

This location is suitable for the purpose, is attractive and accessible from all directions.

The area of the lot on which the present house is built is nearly one-half of that proposed for all four of the societies in 39th St.

The price paid for the former in 1896 was $14.18 per sq. ft.; the price we are asked to pay for the latter is $41.89 per sq. ft., plus the interest to date of occupancy.

6. This society stands for certain principles which individualize its character, among which is the fact that the term "Civil Engineers" used in its title comprehends military, naval, mining, mechanical and electrical engineers, architects and marine architects, as specified in its constitution, all being eligible for membership.

To be housed in the same building with other societies in which different organizations would be shortly termed "civil," "mechanical," "electrical," "mining," etc., would lead to a restriction of the proper meaning of the name of this society in the popular estimation, thus detracting from its dignity and destroying its individuality.

7. The management of the new building will be in the hands of an executive corporation representing all the societies, by which corporation space and expense will be apportioned.

Once having committed ourselves to this project, however, we would be unable to withdraw without secrifice of property, and would be obliged to continue the affiliation with the other societies, even though experiences, now unforeseen, should make it desirable to sever the connection.

The plan of occupation and control of the new building involves an entire and undesirable change in the business management of this society.

Instead of being independent and retaining entire control of its property, as has so far been done with successful results, the expenses in the new building, seems extremely remote, if we believe in the continued future development of our country, in which all branches of the profession of engineering will have an important part; but, if the extremely improbable should occur, and any one of the societies should fail and withdraw, it can hardly be doubted that the others could successfully maintain the building.

Nor can it be reasonably doubted that other engineering or closely allied scientific societies, would avail themselves of any opportunity to locate in the engineering headquarters, whenever such opportunity might be offered.

society will be obliged to surrender control of its real estate to an organization in which it will have only one-fourth interest, the remaining three-fourths being held by other parties.

The proposed executive corporation is to enter upon a speculative business enterprise, viz., the management of a large building, confessedly larger than is demanded by the present needs of the participants in the ownership, in a locality the character of which is now in a transition state from residential to business occupancy, with no great likelihood of future advance in values. Especially can no increase of value be anticipated for a building designed for semi-public uses, the cost of maintaining which will be very great, and will be constant whether it is fully occupied or not.

Participation in such an enterprise is foreign to the aims and objects of the American Society of Civil Engineers, and should not be entered into.

Any loss will fall largely upon the non-resident members of the society, who constitute three-fourths of its membership, and to whom the possession of an inseparable, fractional share of a large building will be of no benefit.

If any of the constituent societies default in the payment of interest, the others would face the necessity of assuming an increased burden or of losing their entire investment.

This society cannot afford to enter into an association in which it might be responsible for the financial failure of others, without adequate protection, which has not yet been assured. This seems a possible danger on account of the present difference in the financial standing of the four national organizations.

The board of direction recommends to the annual meeting the adoption of the following resolutions:

(1) Resolved, That the board of direction be instructed to issue a letter-ballot, to be canvassed at the meeting of the society, March 2, 1904, on the question whether this society shall become one of the constituent societies in the occupancy and control of the proposed union engineering building, under the terms outlined by the joint conference committee.

(2) Resolved, That should a majority of the votes cast be favorable, the board is authorized to proceed in the matter, provided the exemption from taxation of the proposed building is assured, and the interests of the society are otherwise fully safeguarded.

By order of the board of direction.

Chas. Warren Hunt, Secretary.

New York, Jan. 16, 1904.

MR. ANDREW CARNEGIE has offered to increase by half a million dollars his gift for the erection of a Union Engineering House in New York City, provided the American Society of Civil Engineers joins in the enterprise. From rough estimates of the cubic capacity of a building large enough to accommodate the four societies, on the basis of the floor space requirements, stated on p. 602 of our issue of Dec. 31, it is found that its cost would be considerably in excess of the one million dollars originally offered. Mr. Carnegie has therefore offered to increase his gift, as above stated, provided the Civil Engineers join with the other societies and thereby make the larger building necessary.

THE CIVIL SERVICE EXAMINATION held at the Brooklyn Navy Yard in November last, for the purpose of securing assistant civil engineers for the Naval Corps of Civil Engineers resulted in only two men being qualified. The two remaining vacancies will be filled if possible this spring and another examination will be held in March for the selection of candidates.

AN EXAMINATION OF CANDIDATES FOR CHIEF Sanitary Inspector of Chicago was held in that city on Jan. 13. Some of the questions on general sanitation and hygiene were as follows:

Explain the germ theory of disease in its modern aspects.

What are the most prevalent diseases in cities and by what sanitary measures can they be most effectively combated?

What is the latest opinion concerning the dangers to health from leaky plumbing and broken drains?

What are the dangers of poisoning from small quantities of illuminating gas?

Why is it important to secure the drainage of wet places and the removal of stagnant water about dwellings?

What role do insects, such as flies and mosquitoes, play in the transmission of infection?

How does defective tenement-house construction facilitate the spread and maintenance of infection?

What is the scope of work of a sanitary bureau and what is it intended to accomplish?

What measures, in your opinion, are most likely to aid in improving the sanitation of a large, modern city?

What, precisely, do you understand by the term "cleanness" as applied, for example, to streets and alleys, to school houses and other public buildings and to the ordinary dwelling house?

THE MOST SERIOUS RAILWAY ACCIDENT of the week occurred on the New York Central & Hudson River R. R. at Syracuse, N. Y., on Jan. 15. The boiler of a locomotive which was drawing a heavy freight train, exploded and three of the trainmen were killed.

AN EXPLOSION OF DYNAMITE occurred under the Museum of Natural History, New York, Jan. 20, while men were drilling a tunnel to connect two cellars. Investigation showed that about 16 years ago, when the building was being erected, workmen left an unexploded charge of dynamite in the rock. This charge was exploded by the drilling for the work above mentioned. One man was severely injured, but no damage was done to the building. The tunnel was destroyed.

A DYNAMITE EXPLOSION occurred Jan. 9 near Cassville, W. Va., while a number of employes on the Norfolk & Western Ry. extension work were at luncheon. Six men were killed outright and 14 injured. This is the second serious explosion in that vicinity within a month, four men having been killed in a former accident.

A RESERVOIR FAILURE at Bloemfontein, Africa, is reported as having occurred on Jan. 17, resulting in the loss of some 50 lives by drowning and the destruction of three hotels and 176 houses.

AN UNUSUAL ELEVATOR ACCIDENT occurred in St. Louis, Mo., on Jan. 13. A crowd of employes leaving work on the sixth floor of the Brown Shoe Co.'s factory, Washington St. and Eleventh Ave., were waiting for the elevator to come down to the level of that floor. While the elevator was at the floor above, the crowd began pushing toward the elevator shaft, the gate of which had already been raised. Ten persons were pushed down the shaft, and only one or two of these escaped death.

SNOW REMOVAL by means of combined sweepers and loaders, similar to the graders and loaders employed on highway and railway work, is under consideration in New York City by Mr. John McGaw Woodbury, Commissioner of Street Cleaning.

A MODEL FILTER PLANT AT THE ST. LOUIS EXposition, to be constructed and operated by the City of Philadelphia, has been proposed by Mayor Weaver. According to preliminary estimates by Mr. John W. Hill, M. Am. Soc. C. E., Chief Engineer of the Bureau of Filtration, a settling basin, preliminary filters and final filters could be built for $12,000 and operated for $7,000, making allowances for the high prices prevailing at St. Louis. The preliminary filters would be operated at the rate of 20,000,000 and the final filters at 6,000,000 gallons per acre per day.

THE TEMPERATURE OF THE SEWAGE and sewage effluents at the sewage purification works of Plainfield, N. J., during the recent cold snap, with an air temperature of about 10° F., were as follows: At inlet to septic tank, 56°; outlet, do., 55°; effluent from the second contact beds, 53°. At the time of the observations the contact beds were covered with snow. Later, with the upper beds free from snow, and an air temperature of 32°, the temperatures of the sewage and effluent were about as already given. For these figures we are indebted to Mr. Andrew J. Gavett, City Surveyor and Street Commissioner of Plainfield.

COAL DUST AS FUEL is discussed by Mr. C. O. Bartlett in a paper recently read before the Engineering Club of Philadelphia. Three conditions are requisite for the economic combustion of coal in dust form: (1) Uniformity of moisture; (2) uniformity in size of coal grains; (3) proper regulation of air blast. Coal should be dried, and reduced to 80-mesh size. On a basis of 40 tons dried per day with an expulsion of 5% of moisture, the cost of drying is 12 cts. per ton when coal is worth $2 per ton. A 25-HP. mill will pulverize the 40 tons in 10 hours, at a cost of 10 cts. per ton. The cost of conveying and interest on plant will amount to another 10 cts. per ton, making a total cost of 32 cts. per ton for drying and pulverizing. The cost of the plant (4 tons per hour) is estimated at $7,000, distributed thus: Dryer, $1,500; pulverizer, $2,500; feeders, $1,000; conveyors, bins, etc., $2,000. Dust firing not only effects a saving in coal, but does away with the labor of stoking; there is not more than 33% as much ashes to handle and no cinders at all. However, it probably would not pay to install a plant for a consumption of less than one ton per hour.

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